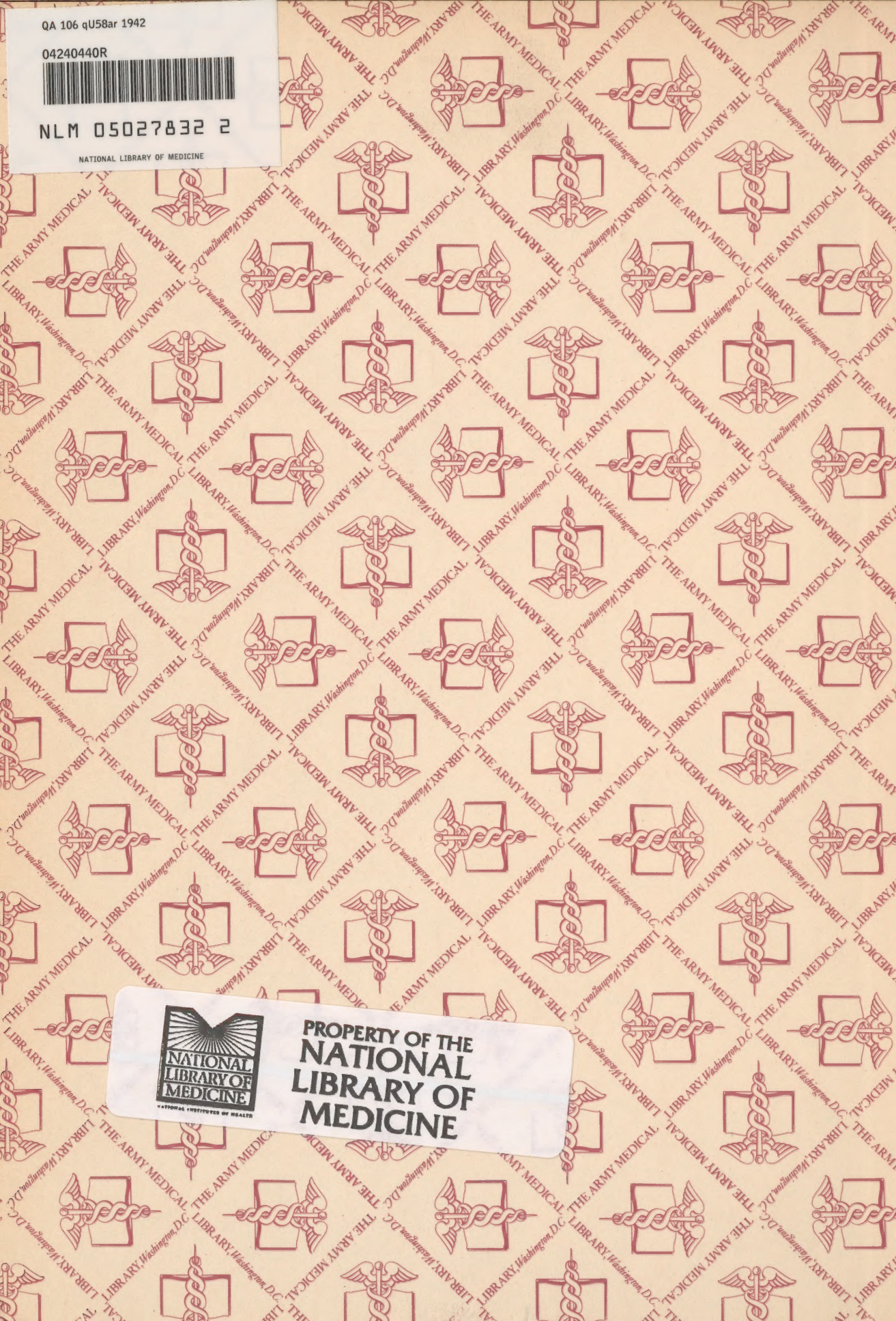

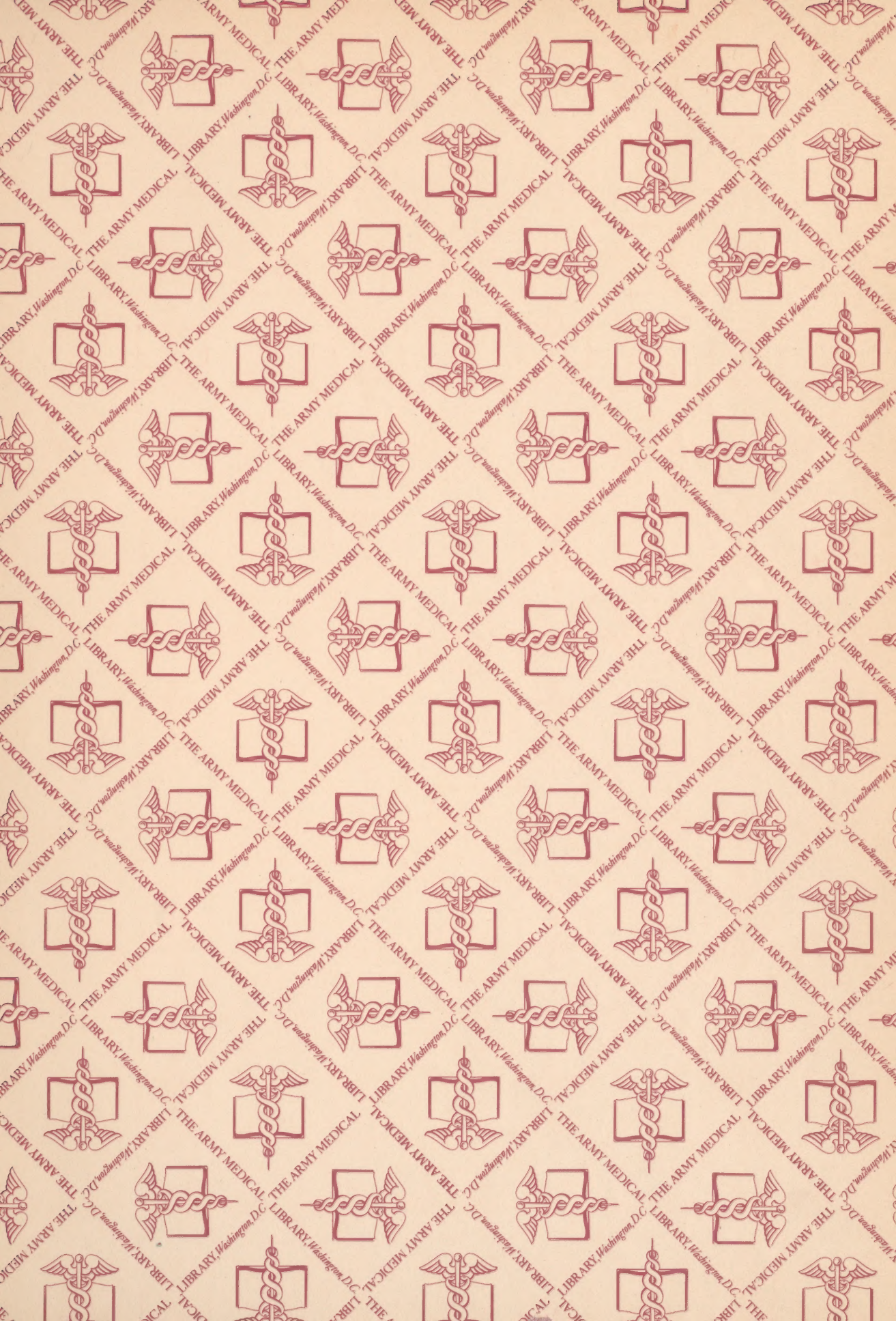
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ARITHMETIC
FOR PHARMACY TECHNICIANS

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ARITHMETIC

For

PHARMACY TECHNICIANS

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ARITHMETIC OF PHARMACY

In no wise does the arithmetic of pharmacy differ from any other arithmetic in so far as its first principles are concerned. The rules of addition, subtraction, division and multiplication apply here exactly as they apply in any other practical application of arithmetic. The decimal point observes the same laws of conduct; the numerator in the fraction sits astride the denominator; the quotient cannot be had until the division is completed--all of these things are in the arithmetic of pharmacy precisely as they are in the arithmetic of commerce, of chemistry, of engineering, or of any other business, trade or profession.

Let the foregoing be clearly understood. The student who undertakes a study of the arithmetic of pharmacy does so in order to become familiar with the solving of those distinct problems which occur in the practice of professional duties. No student in pharmacy who was able to manipulate the fundamental problems of the elementary school arithmetic, need have any fear of finding unusually intricate problems in the work of the pharmacy school or in daily practice.

He need have no FEAR but he must have a wholesome RESPECT. That respect must be for ACCURACY.

It is readily appreciated that the pharmacist must have, besides all of his other qualifications, a sense of the accurate. An incorrect calculation on paper, if put into practice, might cause great disaster and interminable worry. It is obvious when dealing with such substances as aconitine and strychnine, where the dose is a small fraction of a grain, and an error may mean the difference between life and death, that all calculations must be handled with absolute ACCURACY.

The arithmetical principles governing the solution of a problem in compound interest may be exactly the same as those governing the solution of a problem in prescription compounding, but the issues involved are vastly different. One deals with money which may be restored when lost; the other deals with human life which when lost is gone forever.

The two main weaknesses in the arithmetic of the novitiate in pharmacy are in handling fractions and in the placing of the decimal point.

"What is one-half of one-fortieth?"

This question tendered to hundreds of aspirants to college matriculation has always brought more than fifty per cent of incorrect responses. The arithmetic of pharmacy demands much better ground work than is reflected by such a result.

WEIGHTS AND MEASURES

TABLES

I. METRIC SYSTEM

The units of the metric system are Meter, Liter, Gram. The denominations above these units are expressed by adding the Greek prefixes Deka, 10; Hecto, 100; Kilo, 1000. The subdivisions are expressed by adding the Latin prefixes Deci, 0.1; Centi, 0.01; Milli, 0.001. The abbreviations of the units and multiples should begin with capitals, and those of the subdivisions with small letters.

Linear Measure	Volume	Weight		
Kilometer, Km.	Kiloliter, Kl.	Kilogram,	Kg.	1000.0
Hectometer, Hm.	Hectoliter, Hl.	Hectogram,	Hg.	100.0
Dekameter, Dm.	Dekaliter, Dl.	Dekagram,	Dg.	10.0
Meter, M.	Liter, L	Gram,	Gm.	1.0
Decimeter, dm.	Deciliter, dl.	Decigram,	dg.	0.1
Centimeter, cm.	Centiliter, cl.	Centigram,	cg.	0.01
Millimeter, mm.	Milliliter, ml.	Milligram,	mg.	0.001

The prefixes Deka, Hecto, Deci and Centi are seldom used, their equivalents being expressed by use of multiples and subdivisions of their respective units, in the same manner that our decimal currency is expressed. It is customary to use cubic centimeter, cc. in place of the milliliter.

A cubic centimeter of distilled water when weighed in vacuo at 4° C. weighs 1 gram; when weighed in air at 15.6° C. it weighs 0.998 gram.

In ordinary practice, and throughout this course when changing weight to volume, and volume to weight, a cubic centimeter is considered equivalent to one gram of distilled water. This is not strictly accurate, but the error is so small (about 1 to 500) that we will not consider it.

In this course we will not use the linear measure for the reason it finds practically no use in Army Pharmacy. The measures by volume and weight, however, are extensively used and it is necessary that the student understand them thoroughly. He should memorize the following:

Volume

1 Kiloliter = 1000 liters
1 Hectoliter= 100 liters
1 Dekaliter = 10 liters
1 Liter = 1 liter, or 1000 cubic centimeters (1000 cc.)
1 Deciliter = 0.1 liter or 100 cubic centimeters (100 cc.)
1 Centiliter= 0.01 liter, or 10 cubic centimeters (10 cc.)
1 Milliliter= 0.001 liter, or 1 cubic centimeter (1 cc.)

Weight

1 Kilogram = 1000 Grams
1 Hectogram = 100 Grams
1 Dekagram = 10 Grams
1 Gram = 1 Gram, or 1000 milligrams (1000 mg.)
1 Decigram = 0.1 Gram, or 100 milligrams (100 mg.)
1 Centigram = 0.01 Gram, or 10 milligrams (10 mg.)
1 Milligram = 0.001 Gram, or 1 milligram (1 mg.)

2. APOTHECARIES WEIGHT

1 Pound, lb. = 12 Ounces, ℥ = 5760 Grains, gr.
1 Ounce, ℥ = 8 Drams, ℈ = 480 Grains, gr.
1 Dram, ℈ = 3 Scruples, ℈ = 60 Grains, gr.
1 Scruple, ℈ = 20 Grains, gr.

Apothecaries Weight is used only for compounding, and filling prescriptions in civilian pharmacies. Although it is not officially recognized by the Army, it is still necessary for the pharmacy technician to understand it for the reason that some medical officers and contract surgeons still write their prescriptions in the Apothecaries system.

3. APOTHECARIES FLUID MEASURE
Wine Measure

1 Gallon, Cong. = 8 Pints, = 128 Fluidounces.
1 Pint, O. = 16 Fluidounces.
1 Fluidounce, f ℥ = 8 Fluidrams, = 480 Minims, ♏
1 Fluidram, f ℈ = 60 Minims, ♏

The Apothecaries Fluidounce of distilled water weighs, in vacuo, at 4° C. (39.2° F.), 456.379 grains. It weighs in air, at 25° C. (77° F.), 454.6 grains.

4. AVOIRDUPOIS WEIGHTS

1 Pound, lb. = 16 Ounces, = 7000 Grains, gr.
1 Ounce, oz. = 437.5 Grains, gr.

Avoirdupois weights are used entirely for buying and selling drugs, and for commercial transactions.

5. APPROXIMATE MEASURES

The following approximate measures are used routinely in pharmacy work and should be learned:

One tumblerful equals about 8 fluidounces, or 240 cc.
One teacupful equals about 4 fluidounces, or 120 cc.
One wineglassful equals about 2 fluidounces, or 60 cc.
One tablespoonful equals about 4 fluidrams, or 16 cc.
One dessertspoonful equals about 2 fluidrams, or 8 cc.

One teaspoonful equals about 1 fluidram, or 4 cc.

One drop is often considered as equal to about one minim, but the size of drops varies with the character of the liquid, the temperature and the surface from which it is dropped.

6. APPROXIMATE EQUIVALENTS

The following equivalents are not exact, but are sufficiently accurate for all practical purposes:

1 Gram = 15.432 Grains.
1 Cubic Centimeter = 16.23 Minims.
1 Grain = 64.8 Milligrams
1 " = 1.053 Minims
1 Apothecaries Ounce = 31.1 Grams
1 " " = 1.097 Avoirdupois Ounces.
1 " " = 1.053 Fluidounces.
1 Avoirdupois Ounce = 28.35 Grams.
1 " " = 0.911 Apothecaries Ounce.
1 " " = 0.961 Fluidounce.
1 Minim = 0.9493 Grain.
1 Fluidounce = 29.57 Cubic Centimeters.
1 " = 1.04 Avoirdupois Ounces.
1 " = 0.95 Apothecaries Ounces.

From the tables on the preceding pages it will be noticed that the units of the different systems vary to a considerable extent in all respects except the grain which is the same in all systems. For this reason it is well to bear in mind the fact that in converting weights of one system into weights of another system, the student will be less likely to make an error if he first reduces all weights to grains, and then express the quantity in terms of the other system.

7. ADDITION, SUBTRACTION, MULTIPLICATION, AND DIVISION OF WEIGHTS AND MEASURES.

1. EXAMPLE. Add 4 pounds, 6 ounces, 5 drams, and 2 pounds, 8 ounces and 3 drams. (Apothecaries).

4 lb.	6 oz.	5 dr.
2 "	8 "	3 "
7 "	3"	

The sum of the first (lowest) term is 8 dr. This being an ounce it is added to the next higher denomination which makes 15 oz. Since this is in the apothecaries system and there are 12 ounces to 1 pound, 15 oz is 1 lb. 3 oz. The 3 oz. is placed as the final sum of the ounces and the 1 lb. is added to the next higher denomination or pounds which makes 7 pounds.

The operation may also be performed by reducing the terms to the same denomination and proceeding as in simple numbers:

4 lb. = 4 X 12 X 8 = 384 dr.
6 oz. = 6 X 8 = 48 "
2 lb. = 2 X 12 X 8 = 192 "
8 oz. = 8 X 8 = 64 "
5 + 3 = 8 "

696 " = 7 lb. 3 oz.

After determining the number of drams, it becomes necessary to find the number of drams in a pound which is done as follows:

8 dr. = 1 oz.
12 oz. = 1 Apothecaries' pound.
so 8 X 12 = 96. dr. in one pound.

then 96) 696 (7 lb.
672
and 24 dr. left over

there are 8 dr. in one ounce, so:

8)24
3 oz.

The answer, then, is the same as obtained by the other method of solving, ie. 7 lb. 3 oz.

The same method of procedure is followed in subtraction, multiplication and division of compound quantities.

Problems.

Addition of Compound Quantities.

2. Add the following Apothecaries Weights:

5 lb.	4 ℥	3 ℨ	2 ℈	12 gr.
4 "	6 "	5 "	1 "	16 "
3 "	10 "	6 "	2 "	18 "

3. Add the following Avoirdupois Weights:

8 lb.	4 oz.	75 gr.
2 "	12 "	150 "
3 "	8 "	320 "

4. Add 3 gal. 2 qt. 1 pt. 5 dr. 5 oz. 20 min., 1 gal. 1 qt. 9 oz. 45 min. 2 qt. 1 pt. 12 oz. 6 dr., and 1 pt. 15 oz. 2 dr. 50 min.

5. Add the following: 13 gal. 2 qt. 1 pt. 3 qt. 2 gal. 15 gal. 7 gal.

Subtraction of Compound Quantities.

6. Subtract 3 lb. 10 oz. 6 dr. 2 scruples 12 gr. from 6 lb. 5 oz. 1 scruple 10 gr.

	6 lb.	5 oz.	0 dr.	1 ℈	10 gr.
or	5 "	16 "	7 "	3 "	30 "
-	3 "	10 "	6 "	2 "	12 "
	2 "	6 "	1 "	1 "	18 " answer.

Beginning at the right, by successive "borrowing" of units in the minuend, we obtain the numbers in the second line of the problem, from which the numbers in the subtrahend are subtracted.

7. Subtract 1 lb. 8 oz. 5 dr. 2 scruples 15 gr. from 4 lb. 2 oz. 6 dr. 1 scruple.

8. Subtract 12 pt. 15 oz. 3 dr. 27 min. from 25 pt. 5 oz. 9 dr. 21 min.

Multiplication of a Compound Quantity by a Whole Number.

9. Multiply 1 gal. 3 qt. 1 pt. 7 oz. 5 dr. 30 min. by 5.

	1 gal.	3 qt.	1 pt.	7 oz.	5 dr.	30 min.
						5
	5	15	5	35	25	150
or	9 gal.	2 qt.	1 pt.	6 oz.	3 dr.	30 min.

Each number in the multiplicand is separately multiplied by the multiplier and the result simplified, beginning at the right.

10. Multiply 38 gal. 3 qt. 1 pt. 8 f. oz. by 10

11. Multiply 3 lb 5 oz. 7 dr. 2 scruples 12 gr. by 12.

12. Multiply 6 pt. 11 f.oz 7 f.dr. 27 min. by 5.

Division of a Compound Quantity by a Whole Number.

13. Divide 10 lb. 5 oz. 4 dr. 2 scruples 16 gr. by 8.

8)10 lb. 5 oz. 4 dr. 2 scruples 16 gr.
1 lb. 3 oz. 5 dr. 1 scruple 17 gr.

Dividing 10 lb. by 8 we get 1 lb, and the remainder of 2 lb is changed to 24 oz., which is added to the given 5 oz., making 29 oz.; dividing this by 8 we get 3 oz, and the remainder of 5 oz. is changed to 40 dr. which is added to the given 4 dr. making 44 dr;

dividing this by 8, we get 5 dr., with a remainder of 4 dr., which is reduced to scruples; and so on.

14. Divide 226 gal. 1 qt. 1 pt. 4 f.oz. by 3.

15. Divide 40 lb. 8 oz. 206.5 gr. by 7.

16. Divide 48 lb. 9 oz. 1 dr. 1 scruple by 9.

Multiplication of a Compound Quantity by a Common Fraction or by a Mixed Number.

17. Multiply 2 qt. 1 pt. 11 f.oz. 2 f.dr. 40 m by 3/4.

2 qt. 1 pt. 11 f.oz. 2 f.dr. 40 m
3
4)6 qt. 3 pt. 33 f.oz. 6 f.dr. 120 m
1 qt. 1 pt. 20 f.oz. 3 f.dr. 60 m

which = 2 qt. 4 f.oz. 4 f.dr. answer

Multiply the given quantity by the numerator of the fraction, then, without simplifying, divide by the denominator of the fraction. Finally simplify the result, beginning at the right.

18. Multiply 3 gal. 2 qt. 1 pt. 8 f.oz. by 7/8.

19. Multiply 6 lb. 5 oz. 4 dr. 10 gr. by $2\frac{1}{2}$.

A compound quantity may be divided by a common fraction by inverting the divisor and multiplying, though this is seldom required to be done in practical problems.

To Multiply a Compound Quantity by a Decimal.

20. Multiply 1 pt. 3 f.oz. 7 f.dr. 35 m. by 3.2

First change the decimal to a common fraction in lowest terms.

$$3.2 = 16/5$$

1 pt. 3 f.oz. 7 f.dr. 35 m
16
5)16 pt. 48 f.oz. 112 f.dr. 560 m
3 pt. 12 f.oz. 28 f.dr. 160 m

which = 3 pt. 15 f.oz. 6 f.dr. 40 m. answer

21. Multiply 2 qt. 1 pt. 9 f.oz. 6 f.dr. 24 m by 0.35.

22. Multiply 3 lb. 7 oz. 5 dr. 12 gr. by 1.75.

The preceding problems were solved without reducing the compound quantities to simple quantities, and this method should al-

ways be followed if possible, but some types of problems cannot be solved without reduction of the quantities.

Reduction Descending.

23. Reduce 5 lb. 3 oz. 200 gr. to grains.

5 lb.
X 16
80
+ 3
83 oz.
X 437.5
36312.5
+ 200
36512.5 gr., answer

24. Reduce 24 gal. 2 qt. 1 pt. 8 f.oz. to fluidounces.

25. Reduce 15 lb. 5 oz. 2 dr. 4 scruples to grains.

Reduction Ascending.

26. Reduce 71630 m to a compound quantity.

60)71630
8)1193 f.dr. + 50 m
16)149 f.oz. + 1 f.dr.
2)9 pt. + 5 f.oz.
4)4 qt. + 1 pt.
1 gal. + 0 qt. = 1 gal., 1 pt., 5 f.oz.
1 f.dr. 50 m

Collecting the final quotient and the remainders, we have 1 gal. 1 pt. 5 f.oz. 1 f.dr. 50 m., (answer)

27. Express 55360 oz. as a compound quantity.

28. Express 12560 gr. (apoth) as a compound quantity.

29. Express 42937 m as a compound quantity.

30. Express 123504 f.oz. as a compound quantity.

31. What is the weight of a mixture containing 4 ounces, 5 drams, 20 grains, 8 ounces, 410 grains, 7 drams and 50 grains?

32. What is the weight of compound powder of licorice formed by mixing the following: Senna 6 apoth. ounces; glycyrrhiza 7 apoth. ounces, 6 drams, 40 grains; washed sulphur 2 apoth. ounces, 5 drams, 8 grains; oil of fennel 1 dram, 2 grains; and sucrose 16 apoth. ounces, 5 drams, 8 grains?

33. If you have 1 pound, 6 ounces and 240 grains of rhubarb and dispense 4 apoth. ounces, 2 drams at one time and 3 apoth.

ounces, 5 drams and 50 grains at another time, how much will remain?

34. If you have a gallon of alcohol and dispense at different times 1 ounce, $\frac{1}{2}$ pint, $2\frac{1}{2}$ ounces, 6 ounces, 2 pints, 4 ounces and 6 drams, how much will remain?

35. What is the cost of 12 bars of soap at 30 cents a pound if each bar weighs 5 pounds and 6 ounces?

36. Divide 9 gallons, 8 pints and 10 ounces into 5 equal quantities.

37. If you dispense from an ounce of aspirin six 5 grain powders; at another time a dram and a half, and again two and a half drams, how much will you have left?

38. Divide 100 grains of sodium bicarbonate into 12 equal parts, and add to each 2 grains of sodium chloride. What will be the weight of each powder?

39. A can contained one and a half gallons of glycerin, from which has been dispensed 1 pint $3\frac{1}{2}$ fluidounces, at one time and at another time $1\frac{1}{2}$ pints, 4 fluidounces and 6 fluidrams. How much remains in the can?

40. If a gallon mixture requires 1 pound, 4 ounces and 6 drams of drug, how many gallons of mixture can be made from 12 pounds, 6 ounces and 6 drams of the drug?

8. ADDITION OF FRACTIONS

41. What is the weight of a powder that contains the following quantities of various substances: 3/4 grain, 5/6 grain, 7/12 grain and 4/18 grain?

The fractions must be changed to their equivalents having a denominator common to all.

The least common denominator is a multiple of all the factors of the denominators.

$$\begin{array}{r|l} 2 & 4 - 6 - 12 - 18 \\ \hline 2 & 2 - 3 - 6 - 9 \\ \hline 3 & 1 - 3 - 3 - 9 \\ \hline & 1 - 1 - 3 \end{array}$$

The factors 2,2,3,3, contain all the factors of the denominators, and their multiple is the least common denominator which is 36.

To change each fraction to its equivalent having a common denominator, both terms of the fraction must be multiplied by the quotient obtained by dividing the common denominator by the denominator of the fraction.

$36 \div 4 = 9,\ 9 \times \frac{3}{4} = \frac{27}{36}$ $\qquad$ $36 \div 6 = 6,\ 6 \times \frac{5}{6} = \frac{30}{36}$

$36 \div 12 = 3,\ 3 \times \frac{7}{12} = \frac{21}{36}$ $\qquad$ $36 \div 18 = 2,\ 2 \times \frac{4}{18} = \frac{8}{36}$

The sum of the numerators placed over the common denominator is the sum of the fractions.

$$\frac{27}{36} + \frac{30}{36} + \frac{21}{36} + \frac{8}{36} = \frac{86}{36}$$

which, reduced to its simplest form, equals 2 7/18 grains.

Problems

42. Add 1/3, 3/4 and 3/8.

43. Add 1/2, 2/5.

44. Add 1/8, 3/5.

45. Add 1/8, 3/5 and 1/4.

46. Add 2/5, 1/3 and 1/8.

47. If you dispense 1/4 gallon of turpentine to one customer, 3/5 of a gallon to another and 5/8 of a gallon to another, how much will you have dispensed? Reduce the fraction in the answer to its lowest terms.

48. If you purchase 1/4 interest in a business and later an additional 2/5 interest, what part of the building would you then own?

49. If you sell 1/6 of your car at one time and at another time 3/8, what part of the car have you sold?

50. Having dispensed 1/16 of an ounce of quinine at one time, 3/12 of an ounce at another time and 1/8 of an ounce at another time, what part of an ounce have you dispensed?

51. Having dispensed at different times 3/5, 5/6, and 1/8 of a pint of glycerin, how many ounces have you dispensed?

9. ADDITION OF DECIMAL FRACTIONS

When adding decimal fractions write the decimals so that the decimal points will be in a perpendicular line, with tenths under tenths, hundredths under hundredths, etc. Then add as in whole numbers.

52. Example. Add 0.045, 0.5, 0.125, 0.6435.

0.045
0.5
0.125
0.6435
1.3135

Problems

53. If you mix 0.25 of a pint of glycerin, 0.64 of a pint of bay rum and 0.7 of a pint of water, what will be the volume of the mixture?

54. Add 0.506, 0.72, 0.843.

55. Add 0.225, 0.654, 1.52.

56. What is the combined volume of 0.6, 3.15, 2.065 and 0.8502 cc. of water?

57. If you dispense at one time 2.5 ounces of glycerin, at another 4 ounces and at another 3.6 ounces, how many ounces will you have dispensed?

10. SUBTRACTION OF FRACTIONS

See that the fractions have a common denominator, as in the addition of fractions, then subtract the less numerator from the greater and place the difference over the common denominator.

58. Example. Subtract 2/5 from 7/8.
The common denominator of 2/5 and 7/8 is 40. 2/5 = 16/40. 7/8 = 35/40.

35/40 - 16/40 = 19/40.

Problems

59. Subtract 1/6 from 5/8.

60. If you have 3/4 of a pint of ether and lose 1/8 of a pint by evaporation, how much do you have left?

61. If you have 1 3/8 pints of ammonia water and dispense 4/5 of a pint, how much do you have left?

62. If you have a gallon and a half of glycerin and sell 2/5 of a gallon and use 3/10 of a gallon, how much have you left?

63. If you sell 2/5 of your business to one person and 3/8 to another, what part do you still own?

11. SUBTRACTION OF DECIMAL FRACTIONS

Write the less number under the greater, in the same order as in addition of decimals, and subtract, as in whole numbers.

64. Example. Subtract 1.453 from 15.062.

$$\begin{array}{r} 15.062 \\ 1.453 \\ \hline 13.609 \end{array}$$

Problems

65. If chlorinated lime contains 34.65 per cent of available chlorine and has lost 13.85 per cent, what is its strength?

66. Subtract 0.3025 from 0.863.

67. If ammonia water contained 10.35 per cent of NH_3 when received, but later was found to contain 6.95 per cent, how much was lost?

68. Subtract 120.25 from 450.023.

12. MULTIPLICATION OF FRACTIONS

A fraction may be multiplied by multiplying its numerator, or by dividing its denominator.

69. Example. Multiply 2/15 by 5.

$$\frac{5 \times 2}{15} = 10/15 = 2/3.$$

or

$$\frac{2}{15 \quad 5} = 2/3$$

To multiply a fraction by a fraction the numerators are multiplied together for the numerator of the product, and the denominators are multiplied together for the denominator of the product.

70. Example. Multiply 3/5 by 5/6.

$$3/5 \times 5/6 = \frac{3 \times 5}{5 \times 6} = \frac{15}{30} = \frac{1}{2}$$

Problems

71. A medical officer prescribed 16 powders containing 1/6 grain of calomel in each powder. How many grains of calomel will be required?

72. If an elixir calls for 1/5 grain of strychnine in the manufacture of 2 pints of elixir, how much strychnine will be required to make 4/5 of a quart?

73. Multiply 7/20 by 3/4.

74. An Avoirdupois ounce is equal to 28 7/20 grams. How many

grams in 1 4/5 ounces?

75. Multiply 1/5 by 4/5.

76. If a carboy of acid is four fifths full and you use four fifths of this, how much will remain?

77. Multiply 3/5 by 1/6.

78. If you own half interest in something and sell three fourths of your interest, what part of the whole did you sell?

13. MULTIPLICATION OF DECIMAL FRACTIONS

Proceed as in whole numbers, and point off as many decimal places in the product as there are decimal places in the multiplier and multiplicand.

79. Example. Multiply 3.52 by 0.86.

$$\begin{array}{r} 3.52 \\ .86 \\ \hline 2112 \\ 2861 \\ \hline 3.0272 \end{array}$$

Problems

80. Multiply 0.023 by 0.62.

81. Multiply 1.012 by 0.0003.

82. Multiply 6.2 by 3.996.

83. How much strychnine in 50 pills if each pill contains 0.002 of a grain?

84. Multiply 1.084 by 43.426.

85. Pills of phosphorous should contain 0.0006 of a gram in each pill. How much phosphorous will be required to make 125 pills?

86. Multiply 445.524 by 0.781

87. The average dose of Codeine is 0.032 of a gram. How much codeine is necessary to make 60 capsules each to contain an average dose?

88. If a teaspoonful of a certain liquid contains 0.3 of a gram of a certain drug, how much of the drug will a 120 cc. bottle of the liquid contain?

14. DIVISION OF FRACTIONS

A fraction may be divided by dividing its numerator or multiplying its denominator.

90. Example. Divide 6/12 by 3.

$$6/12 \div 3 = \frac{6 \div 3}{12} = \frac{2}{12} = \frac{1}{6},$$

or

$$6/12 \div 3 = \frac{6}{12 \times 3} = \frac{6}{36} = \frac{1}{6}$$

To divide a fraction by a fraction, invert the terms of the divisor and proceed as in multiplication.

91. Example. Divide 3/4 by 2/3.

$$3/4 \div 2/3 = \frac{3}{4} \times \frac{3}{2} = \frac{9}{8} = 1\ 1/8.$$

Problems

92. Divide 5/6 by 4.

93. Divide 7/8 by 2.

94. Divide 1/2 by 1/4.

95. Divide 3/18 by 1/4.

96. The dose of an alkaloid is 3/50 of a grain. How many doses can be obtained from 9/10 of a grain?

97. How many 1/50 grain doses can be obtained from 4/5 of a grain of apomorphine hydrochloride?

98. How many 1/400 grain doses of aconitine can be obtained from 3/80 of a grain of aconitine?

99. A physician prescribes a mixture calling for 3/25 of a grain of atropine. How many 1/50 grain tablets may be used instead of weighing out the alkaloid?

100. How many powders containing 3/8 of a grain of mercurous chloride can be made from $4\frac{1}{2}$ grains of the chloride?

101. Divide 5/6 of a grain of atropine into 45 doses. What will be the weight of each?

16. DIVISION OF DECIMAL FRACTIONS.

Divide as in whole numbers and point off as many decimal places as those in the dividend exceed those in the divisor.

102. Example. Divide 10.695 by 2.3

```
      4.65 answer
   ------------
2.3) 10.695
      92
     -----
      1 49
      1 38
     -----
        115
        115
     -------
```

There are 3 decimal places in the dividend and one in the divisor, so those in the dividend exceed those in the divisor by 2; hence we mark off two places in the quotient or answer.

Problems

103. Divide 23.615 by 8.03.

104. Divide 513.602 by 6.2.

105. Divide 2.648 by 0.073.

106. How many 0.15 gram doses can be dispensed from 2.45 grams of caffeine?

107. How many 0.06 gram doses can be obtained from 1.44 grams of ipecac?

108. How many 0.03 gram powders can be made from 0.48 gram of codeine?

109. How many 0.008 gram doses can be dispensed from 0.192 gram of morphine?

110. How many 0.0006 gram doses can be dispensed from 0.0072 gram of hyoscine hydrobromide?

16. TO CHANGE DECIMAL FRACTIONS TO COMMON FRACTIONS

Decimal fractions may be changed to common fractions by simply writing the decimal in the form of a common fraction and reducing to its lowest terms.

111. Example. Change 0.75 to a common fraction.

$$0.75 = \frac{75}{100} = \frac{3}{4}$$

112. Example. Change 0.0125 to a common fraction.

$$0.0125 = \frac{125}{10000} = \frac{5}{400} = \frac{1}{80}$$

The fraction $\frac{125}{10000}$ was reduced to $\frac{5}{400}$ by dividing both terms by 25 and $\frac{5}{400}$ was reduced to $\frac{1}{80}$ by dividing both terms by 5.

Note that the figures of the decimal form the numerator, and the denominator is 1 with as many ciphers added as there are characters to the right of the decimal point.

Problems

Convert the following decimals to common fractions:

113.	0.6	117.	0.25	120.	0.35
114.	0.08	118.	0.2	121.	0.72
115.	0.64	119.	0.16	122.	0.038
116.	0.125				

123. If the dose of strychnine is 0.025 of a grain, what would be the dose in common fractions?

17. TO CHANGE COMMON FRACTIONS TO DECIMAL FRACTIONS.

Divide the numerator by the denominator expressed decimally.

124. Example. Change 3/4 to a decimal fraction.

$$\frac{3}{4} = 3 \div 4 = 0.75.$$

Problems

Change the following common fractions to the decimal form:

125.	1/6	127.	1/15	129.	1/12	131.	1/200
126.	1/20	128.	1/16	130.	1/4000	132.	1/8

133. If the dose of strychnine is 1/30 of a grain, what would be the dose in a decimal fraction?

134. The dose of adrenalin is 1/120 of a grain. Express the dose as a decimal.

18. TO CHANGE A FRACTION OF ONE DENOMINATION OF WEIGHTS AND MEASURES TO LOWER DENOMINATIONS

When working problems many answers contain a fraction. These can often be eliminated by multiplying the fraction by the number of units of a lower denomination that is required to make one of the given denomination.

135. Example. Remove the fraction from 2.8 pints.

Eight tenths of a pint is reduced to ounces by multiplying by 16, the number of ounces in one pint, which gives 12.8 ounces. Eight tenths of an ounce is reduced to drams by multiplying by 8, the number of drams in one ounce, which gives 6.4 drams. The four tenths of a dram is reduced to minims by multiplying by 60, the number of minims in a dram, which gives 24 minims.

2.8 pints = 2 pints 12 ounces, 6 drams 24 minims.

Problems

136. Reduce 1/6 of a gallon to its lower denominations.

137. Change 0.325 of a pint to the lower denominations of wine measure.

138. How many minims in 1.65 fluidounces?

139. How many grains in 2.258 Avoirdupois ounces?

140. How many grains in 2/5 of an Apothecaries ounce?

141. What is the equivalent, in wine measure, of 612 cubic centimeters?

19. TO CHANGE WEIGHTS AND MEASURES FROM ONE SYSTEM TO THOSE OF ANOTHER

Quantities of weight and measure may be changed from one system to another by reducing the different terms of the system, of which the quantities are given, to grains and dividing by the number of grains in the terms of the desired system.

142. Example. Convert 10 ounces and 2 drams Apothecaries weight into Avoirdupois weight.

Since there are 480 grains in 1 Apothecaries ounce, there are 4800 grains in 10 ounces. In 2 drams there are 120 grains. 4800 gr. + 120 gr. = 4920 gr., and 4920 gr. ÷ 437.5 (the number of grains in an Avoirdupois ounce) = 11 Avoirdupois ounces and 107.5 grains.

Problems

143. Change 34 ounces Apothecaries weight to Avoirdupois weight.

144. Change 5 pounds, 8 ounces Avoirdupois to Apothecaries weight.

145. Change 5 Avoirdupois pounds to Wine measure.

146. Change 60 Apothecaries ounces to Wine measure.

147. Change 10 gallons Wine measure to Avoirdupois Weight.

20. TO CHANGE WEIGHTS AND MEASURES FROM ONE SYSTEM TO THOSE OF ANOTHER BY USE OF EQUIVALENTS

Conversion of Liquid Quantities:

Most useful equivalents:

1 cubic centimeter = 16.23 minims.
1 fluidounce = 29.57 cc.
1 pint = 473 cubic centimeters.
(See also table of approximate equivalents, page 4)

Metric volumes to common volumes:

For small volumes, multiply cubic centimeters by 16.23, to get minims, and reduce the result to a compound quantity if necessary.

For larger volumes, divide cubic centimeters by 29.57, to get fluidounces, and reduce the result to a compound quantity if necessary.

For still larger volumes, divide cubic centimeters by 473, to get pints, and reduce the result to a compound quantity if necessary.

Common volumes to metric volumes:

For small volumes, reduce to minims and divide by 16.23, to get cubic centimeters.

For larger volumes, reduce to fluid ounces and multiply by 29.57, to get cubic centimeters.

For still larger volumes, reduce to pints and multiply by 473, to get cubic centimeters.

148. Example. Convert 2.4 cc. to minims.

2.4 X 16.23 = 38.9 +minims, answer.

149. Example. Convert 1 f.dr. 30 m into cubic centimeters.

1 f.dr. 30 m = 90 m
90 ÷ 16.23 = 5.54 + cc., answer.

150. Example. Convert 2.65 L. into Apothecaries' fluid measure.

2.65 L. = 2650 cc.
2650 ÷ 29.57 = 89.616 + f.dr.
= 5 pt. 9 f.oz. 4 f.dr. 55 +m, answer.

151 Example. Convert 7 f.oz. 5 f.dr. into cubic centimeters.

7 f.oz. 5 f.dr. = 7.625 f.oz.
7.625 X 29.57 = 225.47 + cc., answer.

152. Example. Convert 3 gal. 2 qt. 1 pt. 10 f.oz. into liters.

3 gal. 2 qt. 1 pt. 10 f.oz. = 474 f.oz.
474 X 29.57 = 14016 + cc.
14016 ÷ 1000 = 14.016 + L., answer.

Problems

153. Convert 375 cc. into fluid ounces.

154. Convert 0.3 cc. into minims.

155. Convert 210 cc. into pints.

156. Convert 210 cc. into fluidounces.

157. Convert 2 L. into Apothecaries' fluid measure.

158. Convert 40 cc. into Apothecaries' fluid measure.

159. Convert 3.25 L. into Apothecaries' fluid measure.

160. Convert 4000 cc. into Apothecaries' fluid measure.

161. Convert 1 qt. into cubic centimeters.

162. Convert 42 f.oz. into liters.

163. Convert 4 f.oz. 2 f.dr. into cubic centimeters.

164. Convert 5 pt. 7 f.oz. 6 f.dr. into cubic centimeters.

165. Convert 6 gal. 3 qt. 1 pt. 12 f.oz. into liters.

166. Convert 6 f.oz. 3 f.dr. into cubic centimeters.

167. Convert 2 gal. 1 qt. 1 pt. 12 f.oz. into liters.

Conversion of Weights.

Useful equivalents:

1 avoirdupois pound = 454 grams

(See also table of approximate equivalents, page 4)

Metric weights to common weights.

For small weights, multiply grams by 15.432, to get grains, and reduce the result if necessary.

For larger weights, divide grams by 31.1, to get Apothecaries' ounces, or by 28.35, to get Avoirdupois ounces, and reduce the result to a compound quantity if necessary.

For still larger weights, divide grams by 454, to get avoirdupois pounds, and reduce the result to a compound quantity if necessary.

Common weights to metric weights:

For small weights, reduce to grains, if necessary and multiply by 0.065 to get grams.

For larger weights, reduce to apothecaries' ounces and multiply by 31.1, or to avoirdupois ounces and multiply by 28.35, to get grams.

For still larger quantities, in avoirdupois weight, reduce to pounds, if necessary, and multiply by 454, to get grams, changing the result to kilograms, if necessary.

168. Example. Convert 12.46 Gm. into grains.

$$12.46 \times 15.432 = 192.28 + \text{gr., answer.}$$

169. Example. If 18 grams of mass is divided into 72 pills, how many grains will each pill weigh?

$$18 \times 15.432 = 277.7 + \text{gr.}$$
$$277.7 \div 72 = 3.85 + \text{gr., answer.}$$

170. Example. Convert 684 grams into apothecaries' ounces.

$$684 \div 31.1 = 21.99 + \text{apothecaries' ounces, answer.}$$

171. Example: Convert 347 grams into avoirdupois weight.

$$347 \div 28.35 = 12.24 + \text{oz.}$$
$$0.24 \times 437.5 = 105 \text{ gr.}$$

the answer then is 12 oz. 105 gr., Avoirdupois.

172. Example. Convert 42 Kg. into avoirdupois pounds.

$$42 \text{ Kg.} = 42000 \text{ grams.}$$
$$42000 \div 454 = 92.51 + \text{lb., answer.}$$

173. Example. Convert 6 lb. 12 oz. into kilograms.

6 lb. 12 oz. = 6.75 lb.
6.75 X 454 = 3064.5 Gm.
3064.5 ÷ 1000 = 3.0645 Kg., answer.

174. Example. Convert 750 grams into apothecaries' weight.

750 X 15.432 = 11574 + grains.
11574 ÷ 480 = 24 apoth. oz. 54 gr.
54 ÷ 20 = 2 scruples 14 gr.

So 24 oz. 2 scruples 14 gr., = answer.

175. Example. Convert 6 oz. 5 dr. 30 gr. into grams.

6 oz. 5 dr. 30 gr. = 3210 grains.
3210 ÷ 15.432 = 208 + grams, answer.

176. Convert 8 grams into grains.

177. Convert 275 grams into grains.

178. Convert 96 milligrams into grains.

179. If 8.5 grams of mass is divided into 50 pills, how many grains will each pill weigh?

180. How many 5 grain capsules can be made from half a kilogram of aspirin?

181. How many $\frac{1}{4}$ grain tablets can be made from 25 grams of morphine sulphate?

182. How many 1/60 grain pills can be made from 5 grams of strychnine sulfate?

183. Convert 254 grams into avoirdupois ounces.

184. Convert 8 grams into avoirdupois ounces.

185. If a cubic foot of water weighs 62.5 avoirdupois pounds, what is its weight in kilograms?

186. Convert 1 kilogram into apothecaries' ounces.

187. Convert 786 grams into apothecaries' ounces.

188. Convert 8.5 grams into drams.

189. Convert 18.75 grams into apothecaries' weight.

190. Convert 210 grams into apothecaries' weight.

191. Convert 1281.645 grams into apothecaries' weight.

192. Convert 11 apothecaries' ounces into grams.

193. Convert 1 apothecaries' ounce 2 drams into grams.

194. Convert 7 apothecaries' ounces 5 dr. 16 gr. into grams.

21. MISCELLANEOUS CONVERSIONS

(See table of approximate equivalents, Page 4)

195. Example. Change 10.5 Apothecaries' ounces to Avoirdupois ounces.

The equivalent of one Apothecaries' ounce is 1.097 Avoirdupois ounces. Hence 10.5 X 1.097 = 11.518 Avoirdupois ounces.

Problems

196. Convert 20 fluidounces into cubic centimeters.

197. What is the weight of 75 minims of water?

198. Convert 400 cubic centimeters to fluidounces.

199. How many minims are the equivalent of 170 grains of water?

200. Convert 5000 cubic centimeters into fluidounces.

201. Change 800 grams to Avoirdupois weight.

202. Convert 12 Avoirdupois ounces into grams.

203. Convert 650 grams into Apothecaries' weight.

204. Convert 7.5 Apothecaries' ounces into grams.

205. What is the volume of 10 Avoirdupois pounds of water?

206. What is the avoirdupois weight of a gallon of water?

207. How many cubic centimeters are there in a gallon of water?

208. What is the cost of 12 2-grain powders of codeine sulphate when one ounce costs $5.30?

209. Change the following prescription to the Metric system:

Rx Acetanilidi. . . . . gr. xxxvj
Potassii bromidi. . . . . gr. xxiv
Caffeinae citrat. . . . . gr. xij
Divide in 12 powders.

210. Change to Apothecaries weights and measures.

Rx	Codeinae sulphatis.	0.13 Gm.
	Ammonii chloridi.	8. Gm.
	Syrupi tolutani.	60. cc.
	Aquae. . . . . .ad	90. cc.

RATIO AND PROPORTION

If a common fraction is considered as the division of the numerator by the denominator, it is frequently called a simple ratio; thus the fraction 9/12 is the ratio of 9 to 12, which is written 9:12 and read 9 is to 12.

The value of the ratio of two numbers is the result obtained by dividing the first number by the second.

The numbers involved in a ratio are called its Terms, the first being the antecedent and the second the consequent.

The terms of a ratio can only be abstract numbers or concrete numbers of the same kind; thus we can have the ratio 20:4 or 20 pounds : 4 pounds; and the value of a ratio is always an abstract number. By this is meant that the ratio of 20 pounds to 4 pounds is 5 times, not 5 pounds. There can be no ratio between concrete numbers of different kinds, like 20 cents to 4 pounds, unless they can be considered as abstract numbers.

Since a ratio is also a fraction, its terms may be multiplied or divided by the same number without changing the value of the ratio.

If two ratios are equal, they form a proportion; thus the statement that the ratio of 12 to 4 is equal to the ratio of 15 to 5 is a proportion, since each ratio equals 3, and this proportion may be written

$$12:4 = 15:5 \quad \text{or} \quad 12:4::15:5 \quad \text{or still another way} \quad \frac{12}{4} = \frac{15}{5}$$

all of which means the same thing.

The first and fourth terms of a proportion are called its extremes and the second and third terms are called its means.

In the proportion 12:4 = 15:5

we have $\frac{12}{4} = \frac{15}{5}$

to clear the fraction we cross-multiply which gives

$$12 \times 5 = 15 \times 4$$
$$\text{or} \quad 60 = 60$$

Therefore, the product of the extremes is equal to the product of the means in this proportion, and the same thing is true of any proportion. It follows that either extreme of a porportion is equal to the product of the means divided by the other extreme, and either mean is equal to the product of the extremes divided by the other mean. This important rule is sometimes called "the rule of three," and it can be used to find the missing term of any proportion three of whose terms are known.

It is important to notice that, since a proportion is a statement that two ratios or two fractions are equal, if the third term is greater than the fourth, the first term must be greater than the second, and, conversely, if the third term is less than the fourth, the first term must be less than the second.

Solution of problems by proportion:

211. Example. If 35 pounds of a chemical cost $78.75, how much will 47 pounds cost?

The cost is proportional to the quantity, and the problem is solved by the following method.

Make the quantity which is to be found the fourth term of a proportion and the quantity which is of the same kind the third term. Let x represent the unknown quantity, hence let x be the fourth term.

If, from the conditions of the problem, the fourth term is to be greater than the third term, make the smaller of the remaining quantities the first, and the greater the second term; but if the fourth term is to be smaller than the third term, make the greater of the other quantities the first term and the smaller the second term.

Solve the proportion by dividing the product of the means by the known extreme.

Since cost is required, $78.75 is the third term.

Designating the answer by the letter x, as mentioned above, the work appears as follows:

35 pounds:47 pounds = $78.75:x
or 35:47::78.75:x

35 X x = 35x and 47 X 78.75 = 3701.25
and 35 x = 3701.25

$$x = \frac{3701.25}{35}$$

or x = $105.75, answer.

212. Example. If a certain journey requires 16 hours when

travelling at the rate of 27 miles an hour, how many hours will it require when travelling 36 miles an hour?

Since hours are to be found, the third term is 16 hours.

The time is inversely proportional to the speed, or it will take less time when travelling at the greater speed, so the fourth term will be less than the third term and the second term must be less than the first.

Therefore 36 miles:27 miles = 16 hours:x
or 36:27::16:x

$$x = \frac{27 \times 16}{36}$$

x = 12 hours, answer.

In some problems it is necessary to reduce quantities of different kinds to the same kind, and in other problems terms which are not given directly must be supplied.

213. If 24 men can do a piece of work in 14 days, how many days will it take 21 men to do it?

214. A well is dug in 13 days of 9 hours each. How many days of 10 hours each would it have taken.

215. A man whose step measures 29 inches takes 2480 steps in walking a certain distance. How many steps of 31 inches would be required for the same distance?

216. If 769 pounds of hay cost $6.00, what will 755 pounds cost at the same rate?

217. If 23 gallons of oil cost $4.37, how much will 29 gallons cost?

218. If a man travels 705 miles in 25 days, how many miles will he travel in 23 days?

219. If a man can perform a certain journey in 84 hours, travelling 9 5/9 miles an hour, how many hours will it take him travelling 16 1/8 miles an hour?

220. A bankrupt pays 76 cents on a dollar. If a certain creditor receives $251.75; what was his original claim?

221. If 42 yards of carpet, 27 inches wide, are required to cover the floor of a room, how many yards, 28 inches wide, would be required?

222. A court was paved with 1140 stones, each containing 1 5/6 square feet. What would be the size of the stone if 836 were required?

223. If a train requires 3 1/4 hours to travel a certain distance when running at the rate of 5/13 mile a minute, how many hours will it require when running 7/15 miles a minute?

224. When a post 64 inches high casts a shadow 104 inches long, how high is a steeple that casts a shadow 182 feet long?

225. If a tap discharging 4 gallons a minute empties a cistern in 3 hours, how long will it take a tap discharging 7 gallons a minute to empty the cistern?

226. If a ship sails 1800 miles in 14 days, how many days will it require to make a voyage of 4500 miles?

227. If 3/25 of a ship is worth $2167, what is 7/17 of it worth?

228. Example. If 1 Gm. of a chemical will dissolve in 8.5 cc. of water, how many grams will dissolve in 1 fluid ounce?

1 f.oz. = 29.57 cc.
8.5 cc.:29.57 cc= 1 Gm.:x
x = 3.478 + Gm., answer

Problems

229. If one gram of boric acid will dissolve in 18 cc. of water, how many grams will dissolve in 1 pint of water?

230. The solubility of sodium bicarbonate is 1 part in 12 parts of water. How many apothecaries' ounces will dissolve in 1 liter?

231. If 850 Gm. of sugar are dissolved in sufficient water to make 1 liter of syrup, how many pounds of sugar are required to make 1 gallon of syrup.

232. A pint of solution contains 4 apothecaries' ounces of potassium iodide; how many cc. contain 1 Gm.?

233. Chloroform anodyne contains 2.5 Gm. of morphine sulfate in 1000 cc. How many fluid ounces contain 5 grains?

234. Example. If 1 f.oz. of a solution contains 32 grains of a chemical, how many grams are contained in 250 cc?

1 f.oz. = 29.57 cc.
29.57 cc.:250 cc = 32 gr.:x
x = 270.4 gr.
270.4 ÷ 15.432 = 17.52 Gm., answer.

235. If 1 fluid dram of a solution contains 4.5 grains of a chemical, how many grams are contained in 156 cc.?

236. How many grams of 28 per cent ammonia water will be required to make 500 grams of 10 per cent ammonia water?

237. If 20 pounds of sucrose cost $1.32, what will 75 pounds cost?

238. If a pound of citric acid costs 65 cents, what will 7 ounces cost?

239. When citric acid costs 65 cents a pound, how many ounces can be bought for $1.55?

240. If 12 fluidounces of a substance weighs 142.5 avoirdupois ounces, what will one gallon weigh?

241. If 6 fluidounces of mercury weigh 81.12 avoirdupois ounces, what will a pint weigh?

242. If a 12 ounce bottle holds 162.24 avoirdupois ounces of mercury, how large a bottle will be required to hold 27 ounces?

243. If 165 grams of mercury measure 65 cc., what will a kilogram measure?

244. If 250 cc. of glycerin weighs 312.5 grams, what will 175 cc. weigh?

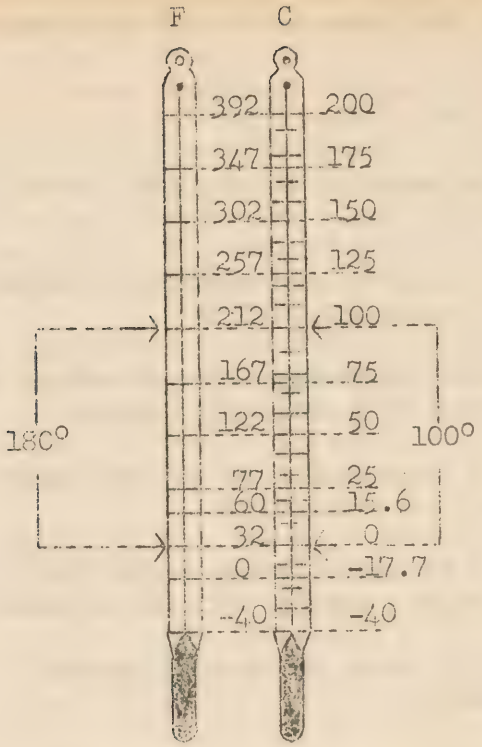
245. If a 5 pound can of glycerin costs $1.55, what will 62 pounds cost?

246. When glycerin costs 28 cents a pound, what will be the cost of a gallon if 20 fluidounces weigh 27 avoirdupois ounces?

THERMOMETER SCALES

A thermometer is an instrument for measuring temperature, or the intensity of heat. The fixed points of a thermometer are the freezing and the boiling point of pure water, each at standard pressure. Degrees of temperature are marked on a thermometer by dividing the space between the fixed points into equal parts and extending the graduation in both directions, for temperatures below the freezing point and above the boiling point of water.

Two kinds of thermometers are in use in the United States, the Fahrenheit thermometer and the centigrade thermometer. On the Fahrenheit thermometer, the fixed points are 32° for the freezing point of water and 212° for the boiling point of water; on the centigrade thermometer, the fixed points are 0° for the freezing point and 100° for the boiling point; thus there are 180 degrees Fahrenheit and 100 degrees centigrade between the fixed points. Degrees below zero are negative numbers and are indicated by a minus sign.



Fahrenheit and Centigrade thermometers

22. TO CONVERT CENTIGRADE TEMPERATURE TO FAHRENHEIT

If 100 centigrade degrees measure the same difference in temperature as 180 Fahrenheit degrees, and we divide by 100, we find that 1° C. equals 1.8° F., or 1° C. = 9/5° F., and conversely 1° F. equals 0.8° C., or 1° F. equals 5/9° C.

By studying the illustration it will be seen that the zero of the Fahrenheit thermometer is 32 degrees below the zero of the Centigrade thermometer. It is therefore necessary to subtract 32 degrees, before multiplying by the equivalent, when changing to Centigrade. And for the same reason, 32 degrees must be added, after multiplying by the equivalent, when changing Centigrade to Fahrenheit.

From this it will be seen that if we multiply any number of centigrade degrees by 9/5 or 1.8 we get the number of Fahrenheit degrees above the freezing point of water, and by adding 32 we get the Fahrenheit temperature. This is expressed by the rule:

To convert centigrade temperature to Fahrenheit temperature, multiply the number of centigrade degrees by 9/5 or 1.8 and add 32.

Expressed as a mathematical formula, this becomes

$$9/5\ C^\circ + 32 = F^\circ$$

This is an algebraic formula and it is necessary to observe carefully the negative sign for degrees below zero on either thermometer.

Since negative 40° on the Centigrade thermometer and negative 40° on the Fahrenheit thermometer are equal, the conversion may be made as follows:

Add 40 to the C. temperature, multiply by 9/5 and subtract 40.

247. Example. Convert 210° Centigrade to Fahrenheit.

$$210^\circ \times 9/5 + 32 = 410^\circ \text{ F., answer.}$$

or, $210^\circ \times 1.8 + 32 = 410^\circ$ F., answer.

or, $210^\circ + 40^\circ \times 9/5 - 40^\circ = 410^\circ$ F., answer.

248. Example. Convert 26° C. to Fahrenheit.

$$9/5 \times 26 = 46.8$$
$$46.8 + 32 = 78.8^\circ \text{ F., answer.}$$

or
$$26 + 40 = 66$$
$$66 \times 9/5 = 78.8^\circ \text{ F., answer.}$$

249 Example. Convert -12° C. to Fahrenheit.

If we multiply a negative quantity by a positive the result is always negative.

$$-12 \times 9/5 = -21.6$$
$$-21.6 + 32 = 10.4^\circ \text{ F., answer.}$$

If we add a number to negative quantity we decrease the negative quantity by the amount that is to be added. Therefore to add 32 to minus 21.6 we must subtract 21.6 from 32 which leaves a plus 10.4° F.

250. Example. Convert -85° C. to Fahrenheit.

$$-85 \times 9/5 = -153$$
$$-153 + 32 = -121^\circ \text{ F., answer.}$$

or,
$$-85 + 40 = -45$$
$$-45 \times 9/5 = -81$$

To subtract a positive from a negative we change the sign of the subtrahend and add,

thus:
$$\begin{array}{r} -81 \\ +\ -40 \\ \hline -121^\circ \text{ F., answer.} \end{array}$$

Problems

251. Convert 10° C. to Fahrenheit.

252. Convert -30° C. to Fahrenheit.

253. Convert 1500° C. to Fahrenheit.

254. Convert -15° C. to Fahrenheit.

255. Convert -20° C. to Fahrenheit.

256. Convert -31.6° C. to Fahrenheit.

257. Convert 4° C. to Fahrenheit.

258. Convert -273° C. to Fahrenheit.

259. Convert -12° C. to Fahrenheit.

260. Convert 40° C. to Fahrenheit.

261. Convert -118° C. to Fahrenheit.

262. Convert 68° C. to Fahrenheit.

263. Convert 20° C. to Fahrenheit.

264. Convert -6° C. to Fahrenheit.

265. Convert 89° C. to Fahrenheit.

266. Convert 200° C. to Fahrenheit.

267. Convert -50° C. to Fahrenheit.

268. Convert 65° C. to Fahrenheit.

269. If a reaction takes place at 71° C., what is the corresponding Fahrenheit temperature?

270. Cacao butter melts at 35° C. What is the corresponding Fahrenheit temperature?

23. TO CONVERT FAHRENHEIT TO CENTIGRADE

Reversing the preceding rule, we have the following:

To convert a Fahrenheit temperature to the corresponding centigrade temperature, subtract 32 from the number of Fahrenheit degrees and multiply by 5/9 or divide by 1.8; or to state it mathematically,

$$(F° - 32) \times 5/9 = C°.$$

271. Example. Convert 140° Fahrenheit to Centigrade.

We have seen that the difference between the freezing and the boiling point of water is 180 degrees for the Fahrenheit, and 100 degrees for the Centigrade. Hence 180 degrees Fahrenheit is equal to 100 degrees Centigrade. Therefore to change Fahrenheit to Centigrade subtract 32 and divide by 1.8.

Thus: 140° -32° ÷ 1.8 = 60° C., answer.

Or, subtract 32 and multiply by 5/9, which is the reciprocal of 1.8 in the form of a common fraction.

Thus: 140° -32° X 5/9 = 60° C., answer.

Or, add 40, divide by 1.8 and subtract 40.
Thus: 140° + 40° ÷ 1.8 (or X 5/9) -40 = 60° C., answer.

The same procedure is followed when changing minus degrees Fahrenheit to Centigrade.

272. Example. Change minus 4 degrees Fahrenheit to Centigrade.

If we subtract a number from an already negative quantity we increase the negative quantity by the amount that is to be subtracted. Therefore, to subtract 32 from minus 4 we must add 32 which gives -36. Minus 36 divided by 1.8 (or multiplied by 5/9) = -20, or 20 degrees below zero Centigrade.

Thus: -4° -32° = -36°, -36° ÷ 1.8 (or multiplied by 5/9) = -20° C., answer.

273. Example. Change 23 degrees Fahrenheit to Centigrade.

If we subtract 32 degrees from 23 degrees we will have as many degrees below zero as the difference between 23 and 32 which is -9°. Minus 9° divided by 1.8 (or multiplied by 5/9) gives -5°C.

Thus: 23° -32° = -9°, -9° ÷ 1.8 (or multiplied by 5/9) = -5° C. answer.

274. Example: At what temperature, Fahrenheit, would the centigrade thermometer read 20° lower than the Fahrenheit thermometer?

By the condition of the problem.

$$C = F - 20$$

By the general formula.

$$9/5\ C + 32 = F$$

Substituting,

$$9/5(F - 20) + 32 = F.$$
$$9(F - 20) + 160 = 5F.$$
$$9F - 180 + 160 = 5F.$$
$$4F = 20$$
$$F = 5°$$ answer.

Problems

275. Convert 59° F. to centigrade.

276. Convert 950° F. to centigrade.

277. Convert -4° F. to centigrade.

278. Convert 77° F. to centigrade.

279. Convert 176° F. to centigrade.

280. Convert -22° F. to centigrade.

281. Convert 36.5° F. to centigrade.

282. Convert 1200° F. to centigrade.

283. Convert 0° F. to centigrade.

284. Convert 25° F. to centigrade.

285. Convert 73° F. to centigrade.

286. Convert 240° F. to centigrade.

287. Convert -62° F. to centigrade.

288. Convert 1246° F. to centigrade.

289. Convert 10° F. to centigrade.

290. If oil of turpentine boils at 310° F., what is the boiling point on the centigrade thermometer?

291. The normal body temperature of a healthy adult is 98.4° F. What is the body temperature on the centigrade thermometer?

DENSITY AND SPECIFIC GRAVITY

The relative weights of equal volumes of substances are shown by their densities and their specific gravities.

Density is the weight of a unit of volume of a substance, as the number of pounds per cubic foot or the number of grams per cubic centimeter.

Specific Gravity is defined as the ratio of the weight of any volume of a substance to the weight of the same volume of a standard, the latter being taken as one.

Water is used as the standard for the specific gravities of liquids and solids, and hydrogen is used as the standard for the

specific gravities of gases.

292. Example. If a piece of sulfur weighs 6.56 G. and the same volume of water weighs 3.28 Gm. What is the specific gravity of the sulfur?

$$\frac{\text{Weight of sulfur}}{\text{Weight of water}} = \frac{6.56}{3.28} = \frac{2}{1} = 2$$

so we say that the specific gravity of the sulfur is 2.

The calculation of the specific gravity of a liquid or a solid generally reduces to the division of the weight of a portion of the substance by the weight of the same volume of water, and the result tells how many times as heavy as water the substance is. Thus, in the above example the specific gravity of sulfur is 6.56 ÷ 3.28 = 2.

Specific gravities do not generally equal whole numbers, and they are expressed decimally to as many places as the accuracy of their determination warrants. In pharmaceutical work, this is generally to two, three, or four decimal places.

Since substances expand or contract at different rates, when the temperature changes, the specific gravity of a substance varies with the temperature, and this must be carefully looked after in accurate work. In the United States Pharmacopoeia, the standard temperature is 25° centigrade for specific gravities, excepting that of alcohol, which is to be taken at 15.56° Centigrade to conform to government regulations.

Densities of substances are concrete numbers, while specific gravities being ratios, are abstract numbers.

The specific gravity of a substance and its density in the metric system are numerically equal, but they are quite different when the density is expressed in the common system.

Specific gravity is frequently used in pharmaceutical and chemical work; density is not used much. Their study belongs to the subject of physics.

The only use to which we will put specific gravity in this course is for the purpose of converting volume to weight and weight to volume.

The weights of equal volumes and the volumes of equal weights of liquids are proportional to their specific gravities.

The weight of a given volume of a liquid is calculated by multiplying the weight of an equal volume of water by the specific gravity of the liquid, and the volume of a given weight of a liquid is calculated by dividing the weight of an equal volume of water by the specific gravity of the liquid.

Because of the simple relationship between the units in the metric system such problems are simple and more easily done when only metric quantities are involved, but they become more complicated when units of the common system of weights and measures are used.

24. TO CALCULATE THE WEIGHT OF A LIQUID OF KNOWN SPECIFIC GRAVITY WHEN THE VOLUME IS GIVEN IN METRIC UNITS.

293. Example. What is the weight of 3620 cc. of alcohol, having a specific gravity of 0.816?

3620 cc. of water weigh 3620 Gm.
3620 X 0.816 = 2953.92 Gm., answer.

Problems

294. How many grams will 100 cc. of hydrochloric acid, specific gravity 1.16, weigh?

295. What is the weight of 300 cc. of a liquid having a specific gravity of 1.25?

296. What is the weight, in grams, of 14 cc. of mercury, S. G. = 13.6?

297. How many grams will 225 cc. of sulfuric acid, S. G. = 1.83 weigh?

298. What is the weight of 684 cc. of chloroform, S. G. = 1.49?

299. If the specific gravity of alcohol is 0.812, what is the weight in kilograms of 12 hektoliters?

25. TO CALCULATE THE WEIGHT OF A LIQUID OF KNOWN SPECIFIC GRAVITY WHEN ITS VOLUME IS GIVEN IN ENGLISH UNITS:

One fluid ounce (480 minims) of water weighs 454.6 grains at 25° C.

Avoirdupois weight is understood unless apothecaries' weight is indicated.

300. Example. Calculate the avoirdupois weight of 8 fluidounces of paraldehyde, S. G. 0.990.

454.6 X 0.99 = 450 gr. in 1 f.oz.
450 X 8 = 3600 gr. in 8 f.oz.
3600 gr= 8 oz. 100 gr., answer.

301. Example. How many avoirdupois pounds do 2 gallons of oil of turpentine, S. G. 0.865, weigh?

16 X 8 X 2 = 256 f.oz.
454.6 x 0.865 = 393.23 gr. in 1 f.oz.
393.23 X 256 = 100666 grains.
100666 ÷ 7000 = 14.38 lb., answer.

302. Calculate the weight of 1 minim of water.

303. How many grains does 1 pint of water weigh?

304. What is the difference in weight between a pint of water and a pound of water?

305. How many avoirdupois pounds does 1 gallon of water weigh?

306. Calculate the apothecaries' weight of 1 pint of chloroform, S. G. 1.476.

307. What is the difference in weight between a pint and 1 pound of chloroform? S. G. = 1.475.

308. How many avoirdupois ounces does a fluid ounce of mercury S. G. 13.5 weigh?

309. Calculate the avoirdupois weight of 2 pints of ether, S. G. 0.725.

310. If the specific gravity of ether is 0.719, what is the apothecaries' weight of 4 fluid ounces?

311. Calculate the apothecaries' weight of 2 pints of alcohol S. G. 0.812.

26. TO CALCULATE THE WEIGHT, IN UNITS OF THE METRIC SYSTEM, OF A LIQUID OF KNOWN SPECIFIC GRAVITY, WHEN ITS VOLUME IS GIVEN IN UNITS OF THE ENGLISH SYSTEM.

312. Example. What is the weight, in grams, of 4 f.oz. of a liquid whose specific gravity is 1.25?

29.57 X 4 = 118.28 cc.
118.28 X 1.25 = 147.85 Gm. answer.

NOTE--In this type of problem, it is generally best to convert the given volume to its metric equivalent at once, and then solve the problem in the metric system.

Problems

313. If the specific gravity of a liquid is 1.36, what does 1 gallon weigh in Kg?

314. What is the weight in grams of 3 fluid ounces of water?

315. What is the weight in grams of 1 pint of chloroform? S. G. --1.476.

316. What is the weight in grams of 1 quart of oil, S. G. --0.87?

317. Calculate the weight in grams of 2 pt. 8 fluid ounces of hydrochloric acid, S. G.--1.15.

318. Calculate the weight in Kg. of 1 gallon ammonia water, S. G. --0.96.

319. What is the weight in Kg. of 5 pints of a liquid, S. G. --0.76?

27. TO CALCULATE THE WEIGHT, IN UNITS OF THE COMMON SYSTEM, OF A LIQUID OF KNOWN SPECIFIC GRAVITY, WHEN ITS VOLUME IS GIVEN IN UNITS OF THE METRIC SYSTEM:

320. Example. What is the weight of 50 cc. of ether, in grains? S. G. 0.715.

In problems of this type, it is generally best to solve the problem in the metric system and convert the weight to the common system at the end.

50 X 0.715 = 35.75 Gm.
15.432 X 35.75= 551 gr., answer.

Problems

321. What is the weight of 95 cc. of chloroform, in grains? S. G. 1.476.

322. How many grains do 512 cc. of alcohol weigh? S. G. 0.814.

323. Calculate the weight, in grains, of 125 cc. of nitric acid, whose specific gravity is 1.40.

324. How many avoirdupois ounces do 1260 cc. of an oil weigh, if its specific gravity is 0.924?

325. How many pounds does 1 liter of glycerin weigh? S. G. 1.251.

326. What is the avoirdupois weight of 4370 cc. of syrup having a specific gravity of 1.33?

327. What is the apothecaries' weight of 350 cc. of a liquid whose specific gravity is 0.864?

328. What is the weight, in avoirdupois pounds, of 2 hekto-liters of oil having a specific gravity of 0.928?

28. TO FIND THE VOLUME, IN THE METRIC SYSTEM, OF A LIQUID OF KNOWN SPECIFIC GRAVITY, WHEN ITS WEIGHT IS GIVEN IN THE METRIC SYSTEM.

329. Example. What is the volume of 492 Gm. of nitric acid, in cubic centimeters? S. G. 1.40.

Since the weight is equal to the volume multiplied by the density, in the metric system, the volume is most easily obtained by dividing the weight by the density.

$$492 \div 1.40 = 351.5 \text{ cc., answer.}$$

330. What is the volume in cc. of 600 grams of liquid, S. G. --1.35?

331. If ether has S. G. of 0.715, how many cc. do 180 grams measure?

332. What is the volume of 100 grams of chloroform, in cc. S. G. --1.475.

333. What is the volume of 450 grams of glycerin, in cc. S.G. --1.25?

334. How many cc. in 1 Kg. Sulfuric acid? S. G.--1.83?

335. What is the volume of 1200 grams of ether in cc. S. G. --0.714?

336. How much, by measure, of nitric acid should be used in a recipe calling for 65 Gm.? S. G. 1.403.

337. A recipe calls for 425 Gm. of hydrochloric acid, S. G. 1.155. How many cubic centimeters does this quantity measure?

338. How many liters do 4550 Gm. of sulfuric acid measure? S. G. 1.832.

29. TO FIND THE VOLUME, IN COMMON MEASURE, OF A LIQUID OF KNOWN SPECIFIC GRAVITY, WHEN ITS WEIGHT IS GIVEN IN THE COMMON SYSTEM.

339. Example. How many minims will 360 grains of chloroform measure? S. G. 1.475.

$$454.6 \times 1.475 = 670.5 \text{ gr., weight of 480 m. chloroform.}$$

$$670.5 \text{ gr.}:360 \text{ gr.}::480 \text{ m.}:x$$

$$x = 257 \text{ m., answer.}$$

or,

$$360 \times 1.053 = 379.08 \text{ m}$$

$$379.08 \div 1.475 = 257 \text{ m., answer.}$$

Problems

340. How many minims will 56 grains of sulphuric acid measure; S. G. 1.832.

341. How many minims will 4 avoirdupois ounces of glycerine measure? S. G. 1.25.

342. Calculate the volume of 1 grain of water.

343. How many minims in 1 avoirdupois ounce of water?

344. How many minims in 1 apothecaries' ounce of water?

345. How many fluid ounces does 1 avoirdupois pound of hydrochloric acid measure? S. G. 1.155.

346. How many fluid ounces are contained in a half-pound can of ether? S. G. 0.714.

347. How many fluid ounces will 1 pound of glycerine measure? S. G. 1.25.

348. What is the volume, in fluid ounces, of 3 pounds of ether? S. G. 0.715.

349. How many fluid ounces will 5 pounds of oil of wintergreen measure? S. G. 1.185.

30. TO CALCULATE THE VOLUME, IN COMMON MEASURE OF A LIQUID OF KNOWN SPECIFIC GRAVITY, WHEN ITS WEIGHT IS GIVEN IN THE METRIC SYSTEM.

350. Example. What is the volume, in fluid ounces, of 1600 Gm. of a liquid with a specific gravity of 1.314?

$$1600 \div 1.314 = 1217.65 \text{ cc.}$$
$$1217.65 \div 29.57 = 41.17 \text{ f.oz., answer.}$$

Problems

351. How many fluid ounces will 1 Kg. of alcohol measure? S. G. 0.815.

352. How many fluid ounces will 500 Gm. of chloroform measure? S. G. 1.475.

353. Nitric acid has a specific gravity of 1.40. What is the volume of 1 Hektogram?

31. TO CALCULATE THE VOLUME, IN METRIC MEASURE, OF A LIQUID OF KNOWN SPECIFIC GRAVITY, WHEN ITS WEIGHT IS GIVEN IN THE COMMON SYSTEM.

354. Example. How many cubic centimeters will 4 apothecaries' ounces of hydrochloric acid measure if the specific gravity is 1.154?

31.1 X 4 = 124.4 Gm.
124.4 ÷ 1.154 = 107.79 cc., answer.

Problems

355. How many cubic centimeters will 1 pound of sulfuric acid measure, if the specific gravity is 1.83?

356. How many cubic centimeters will 12 avoirdupois ounces of glycerine measure? S. G. 1.25.

357. How many cubic centimeters will 1 pound of ether measure, if the specific gravity is 0.715?

358. How many cubic centimeters will 3 pounds of glycerine measure, specific gravity 1.25?

359. How many cubic centimeters of chloroform liniment can be made from 1 pound of chloroform? S. G. = 1.475.
(300 cc. of chloroform in 1000 cc. of liniment.)

32. MISCELLANEOUS PROBLEMS ON WEIGHTS AND VOLUMES OF LIQUIDS

Problems

360. Which is heavier and by how much: 1 fluid ounce of mercury, S. G. 13.6, or 1 pint of turpentine, S. G. 0.85?

361. In making syrup, 850 Gm. of sugar are dissolved in enough water to make 1000 cc. S. G. of syrup = 1.313. Calculate the amount of water used.

362. If a bottle will hold 47.16 Gm. of syrup, S. G. 1.315, how many grams of nitric acid, S. G. 1.42, will it hold?

33. CALCULATION OF DOSES

363. Example. If 3 f.oz. of a liquid contain 48 doses, what is the volume of each dose.

480 X 3 = 1440 minims
1440 ÷ 48 = 30 minims, answer.

364. Example. If a preparation contains 5 Gm. of quinine sulfate in 500 cc., how much is contained in each tablespoonful?

1 tablespoonful = 15 cc.
500 cc.:15 cc.= 5 Gm.:x
x = 0.15 Gm., answer.

365. Example. If a pint of a mixture contains 6 grains of an alkaloidal salt, how much is contained in each tablespoonful?

1 tablespoonful = 4 f.dr.
8 X 16 = 128 F.dr. in 1 pint.
128:4 = 6:x
x = 3/16 grain, answer.

366. Example. Rx--Sodium citrate. . . . . dr. i
Potassium acetate. . . . . .dr. iss
Aromatic elixir. . . . . q.s.,ad f.oz.ii
Mix

How many grains of each of the first two ingredients in each ½ teaspoonful?

½ teaspoonful = ½ f.dr.
8 X 2 = 16 f.dr.
1 dr. = 60 gr., so 1½ dr. = 90 gr.

16 f.dr.:½ f.dr. = 60 gr.:x
x = 1 7/8 gr. sodium citrate

16 f.dr.:½ f.dr. = 90 gr.:y answers
y = 2 13/16 gr. Potassium acetate.

Problems

367. How much arsenic trioxide is contained in each pill, if a mass containing 1¼ grains is divided into 30 pills?

368. If 8 f.oz of a liquid contain 240 doses, what is the volume of each dose?

369. A powder contains 1/24 grain of hyoscine hydrobromide. If it is divided into 12 equal parts, how much hyoscine hydrobromide will each part contain?

370. If a preparation contains 0.8 Gm. of strychnine in 1000 cc., how much is contained in 1 teaspoonful?

371. If a preparation contains 0.10 Gm. of strychnine in 100 cc., how much is contained in each teaspoonful?

372. If a solution contains 36 grains in 12 f.oz., what fraction of a grain is contained in 2 fluid drams?

373. If a solution of strychnine sulfate contains 4 gr. in 1 pint, how much is contained in 2 f.dr.?

374. If 1 pint of a solution contains 704 gr. of a chemical,

how much is contained in each fluid dram?

375. A 4 ounce mixture contains 64 grains of quinine sulfate how many grains of the salt are contained in 4 cc.?

376. If a 6 ounce mixture contains 3/4 gr. of strychnine sulfate, how much of the salt is contained in 1 dessertspoonful?

377. Rx-- Tincture of nux vomica. 8.0
Solution of potassium arsenite. . . . 4.0
Tincture of ferric citrochloride. . .16.0
Elixir of pepsin. . . . . q.s. 120.0
Mix

How much of each of the first three ingredients in each teaspoonful?

378. Rx-- Compound extract of colocynth. . . . 80.0
Mild mercurous chloride. 60.0
Resin of jalap. 20.0
Gamboge. 15.0
Diluted alcohol, q.s.
To make 1000 pills.

How many grains of each ingredient in each pill?

379. Rx-- Reduced iron. . . . . gr. xx
Zinc phosphide. . . . . gr. i
Strychnine sulfate. . . . . gr. ss
Quinine Sulfate. . . . . dr. iss
Extract of cascara. . . . . dr. i
To make 30 pills.

What is the dose of each ingredient in each pill in grams?

380. How many 20 minim doses are contained in 40 cc. of a liquid?

381. How many 15 minim doses are contained in 60 cc. of tincture of digitalis?

382. How many 6 grain doses are contained in 12 grams of a powder?

383. How many 10 grain doses are contained in 20 Gm. of a powder?

384. If the dose of aconitine is 0.00015 Gm., how many doses are there in 0.120 Gram?

385. If the dose of ammonium bromide is 10 grains, how many doses are contained in 6 fluid ounces of elixir of ammonium bromide, N. F., if 1000 cc. of this preparation contains 85 Gm.?

386. If the dose of sodium arsenate is 1/12 grain, how many doses are contained in 1 fluid dram of Pearson's solution, if 100 cc. contain 1 Gm?

387. Example. How much of a chemical is required to make a 3 ounce mixture, each dessertspoonful of which will contain 0.016 Gm. of the chemical.

$$29.57 \times 3 = 88.71 \text{ cc.}$$
$$1 \text{ dessertspoonful} = 8.0 \text{ cc.}$$
$$8:88.71::0.016:x$$
$$x = 0.177 \text{ Gm., answer.}$$

388. How many grams of arsenic trioxide are required to make a 2 ounce mixture, each teaspoonful of which will contain 1/25 grain?

389. How many grams of arsenic trioxide are required to make a 4 ounce mixture, each teaspoonful of which will contain 1/30 grain?

390. How many cubic centimeters of fluid extract of belladonna are required to make a four ounce mixture, each teaspoonful of which will contain 130 mg. of belladonna?

391. A 6 ounce mixture contains in each 4 cc. 1/6 grain of codeine phosphate. How many grains of the salt does the entire mixture contain?

392. Example. If a trituration contains 5 grains of strychnine sulfate in $\frac{1}{2}$ ounce, how many grains will contain $\frac{1}{4}$ grain of the salt?

$$480 \times \tfrac{1}{2} = 240 \text{ gr.}$$
$$5 \text{ gr.}:\tfrac{1}{4} \text{ gr.} = 240 \text{ gr.}:x$$
$$x = 12 \text{ gr., answer.}$$

393. If 2 fluid ounces of a solution of strychnine sulfate contain 6 grains of the salt, how many minims contain 1/80 grain?

394. If a solution contains 74 grains of a chemical in a pint, what volume contains 1 grain?

395. If a solution of strychnine sulfate contains 4 grains in each fluid ounce, what volume contains 1/120 grain?

396. If a trituration contains 1 grain of strychnine sulfate in each dram, how many grains will contain 1/6 gr. of the salt?

397. Chloroform anodyne, N. F., contains 2.5 Gm. of morphine sulfate in 1000 cc. What volume contains 1 grain of the salt?

34. CALCULATION OF DOSES FOR CHILDREN

The commonly used method for calculating the dose for a child

from the dose for an adult is by Young's rule, which is as follows:

Divide the age of the child in years by the age plus 12 and multiply the result by the adult dose.

This rule is better expressed by a mathematical formula, as follows:

$$\frac{\text{age}}{\text{age} + 12} \times \text{adult dose} = \text{dose for child.}$$

398. Example. If the adult dose of a medicine is 6 grains, what is the dose for a child 3 years old?

$$\frac{3}{3 + 12} \times 6 = 1/5 \times 6 = 6/5 = 1\ 1/5 \text{ gr., answer}$$

399. Example. If the adult dose of a medicine is 1/20 grain, what is the dose for a child 4 years old?

$$\frac{4}{4 + 12} \times 1/20 = 1/4 \times 1/20 = 1/80 \text{ gr., answer.}$$

400. Example. If the adult dose of a drug is 0.125 Gm., what is the dose for a child 9 years old?

$$\frac{9}{9 + 12} \times 0.125 = 3/7 \times 0.125 = 0.053 \text{ Gm., answer.}$$

401. Example. If the adult dose of a drug is 0.032, what is the dose for a child 6 months old?

6 months = 1/2 year.

$$\frac{1/2}{1/2 + 12} \times 0.032 = 1/25 \times 0.032 = 0.00128 \text{ Gm., answer.}$$

Problems

402. If the dose of Dover's powder for an adult is 8 grains, what is the dose for a child of four?

403. If the dose of tincture of aconite for an adult is 5 minims, what is the dose for a child five years old?

404. If the dose of morphine sulfate for an adult is 1/8 grain, what is the dose for a child six years old?

405. If the adult dose of compound licorice powder is 1 dram, what is the dose for a child of 3?

406. If the dose of strychnine sulfate for an adult is 1/60 grain, what is the dose for a child 8 years old?

407. If the adult dose of a drug is 10 grains, how much should be given to a child 10 years old?

408. If the adult dose of a drug is 20 grains, what is the dose for a child 2 years old?

409. If the dose of camphor for an adult is 5 grains, what is the dose for a child 12 years old?

410. If the adult dose of a drug is 15 grains, what is the dose for a child 5 years old?

411. If the adult dose of a drug is 2.5 grains, what is the dose for a child 9 years old?

412. If the adult dose of a medicine is 15 drops, what is the dose for a child 3 years old?

413. If the adult dose of a drug is 0.324 Gm., what is the dose for a child of six?

414. If the adult dose of nux vomica is 0.065 Gm., what is the dose for a child 4 years old?

415. If the adult dose of aloes is 0.25 Gm., what is the dose for a child 9 years old?

416. If the dose of a medicine is 10 Gm., what is the dose for a child 6 years old?

417. If the dose of a medicine is 2.5 Gm., what is the dose for a child 2 years old?

418. If the adult dose of a drug is 0.065, what is the dose for a child 9 months old?

419. If the adult dose of a medicine is 2 cc., what is the dose for a child 18 months old?

420. If the adult dose of a drug is 0.005 Gm., what is the dose for a child 30 months old?

421. Calculate the dose of morphine sulfate for a 7 months old baby, if the adult dose is 0.008 Gm.

422. If the adult dose of codeine is 32 mg., what is the dose for a child 10 months old?

35. TO DETERMINE QUANTITIES USED IN MANUFACTURING.

To calculate the quantities of the ingredients in a mixture when a recipe is given in the metric system or in parts by weight and the required quantities are to be in metric units.

423. Example. How many grams of each ingredient are required in the manufacture of 35 grams of Compound Chalk Powder? The following proportions are given:

Prepared chalk	30 Gm.
Acacia	20 Gm.
Sucrose	50 Gm.
To make	100 Gm.

The quantity to be made, 35 grams is 35/100 of 100 grams, the amount of the formula. Hence we must take 35/100 of the amount given for each ingredient, and we have as follows: Prepared chalk 10.5 grams, acacia 7 grams, and sugar 17.5 grams.

To solve problems of this type it is only necessary to divide the quantity of each ingredient given in the formula by the total amount the formula makes, and multiply this quotient by the total amount to be made.

Or they may be solved by ratio and proportion:

100:30::35:x
x = 10.5 Gms. prepared chalk.
100:20::35:x, x = 7 Gms. acacia
100:50::35:x, x = 17.5 Gms. sugar.

To check your result add up the answers obtained:

10.5 + 7 + 17.5 = 35 Gm.

424. From the following formula, calculate the quantities of each ingredient to make 227 grams of camphor ointment:

Camphor	22.0 Gm.
White Wax	11.0 Gm.
Lard	67.0 Gm.
To make	100.0 Gm.

425. From the following recipe, calculate the number of grams of each ingredient required to make 454 grams of borated talcum:

Boric Acid	6.0 Gm.
Starch	10.0 Gm.
Talcum	84.0 Gm.
To make	100.0 Gm.

426. From the following formula, calculate the number of grams of each ingredient required to make 2800 grams of the mixture?

Talcum	87.0 Gm.
Starch	8.0 Gm.
Salicylic acid	5.0 Gm.
To make	100.0 Gm.

427. From the following recipe, calculate the number of grams of each ingredient required to make 1500 Gm. of the mixture:

Sulfur	5 parts.
Copperas	1 part
Charcoal	4 parts
Nux vomica	3 parts

428. From the following formula, calculate the quantities of each ingredients required to make 475 cc. of stronger tincture of iodine, N. F.:

Iodine	165 Gm.
Potassium Iodide	35 Gm.
Water	250 cc.
Alcohol, a sufficient quantity	
To make	1000 cc.

429. From the following recipe, calculate the quantities of each ingredient to make 235 cc. of chalk mixture.

Prepared chalk	6 Gm.
Glycerine	10 cc.
Cinnamon water	40 cc.
Distilled water, q.s., ad.	100 cc.

To calculate the quantity of each ingredient in a mixture when the recipe is given in the metric system or parts by weight and the required quantity is in the common system.

In this case, it is generally best to convert the required quantity into the metric system, and to leave the results in the metric system, unless otherwise specified.

430. Example. Calculate the quantities of each ingredient required to make 5 avoirdupois pounds of borated talcum powder by the following recipe:

Boric Acid	60 Gm.
Starch	100 Gm.
Talcum	840 Gm.

454 X 5 = 2270 Gm. in 5 pounds.
60 + 100 + 840 = 1000 Gm.
1000 Gm.:2270 Gm. = 60 Gm.:x, x = 136.2 Gm. of Boric Acid. (answer)
1000 Gm.:2270 Gm. = 100 Gm.:y, y = 227 Gm. of Starch. (answer)
1000 Gm.:2270 Gm. = 840 Gm.:z, z = 1906.8 Gm. of Talcum. (answer)
Check: 136.2 + 227 + 1906.8 = 2270 Gm.

431. From the following recipe, calculate the number of grams of each ingredient required to make 8 apothecaries' ounces.

Powdered chalk. . . . . 30 Gm.
Acacia. . . . . 20 Gm.
Sucrose. . . . . .50 Gm.

432. From the following recipe, calculate the number of grams of each ingredient required to make 1 avoirdupois pound.

Pine tar. . . . . 500 Gm.
Yellow wax. . . . . 150 Gm.
Petrolatum. . . . . 350 Gm.

433. From the following formula, how much of each ingredient should be used to make 5 avoirdupois pounds of compound acetanilid powder, N. F.?

Acetanilid. . . . . 70 Gm.
Caffeine. . . . . 10 Gm.
Sodium bicarbonate. . . . . 20 Gm.

434. From the following formula, how much of each ingredient should be used to make 1.25 avoirdupois pounds of compound licorice powder?

Senna, powdered. . . . . 180 Gm.
Glycyrrhiza, powdered. . . . . 236 Gm.
Washed sulphur. . . . . 80 Gm.
Oil of fennel. . . . . 4 Gm.
Sugar. . . . . 500 Gm.

435. From the following formula, calculate the quantity of each ingredient required to make 1 avoirdupois pound of Dover's powder.

Powdered Ipecac. . . . . 1 part
Powdered Opium. . . . . 1 part
Powdered Lactose. . . . . 8 parts

436. From the following recipe, calculate the quantities required to make $\frac{1}{2}$ gallon of soap liniment, U.S.P.

Powdered Soap. . . . . 60 Gm.
Camphor. . . . . 45 Gm.
Oil of Rosemary. . . . . 10 cc.
Alcohol. . . . . .700 cc.
Water, a sufficient quantity,
To make. . . . . 1000 cc.

437. From the following recipe, calculate the quantities required to make 4 fluid ounces of compound syrup of senna.

Fluid extract of senna. . . . . 135 cc.
Fluid extract of rhubarb. . . . . 35 cc.
Fluid extract of buckthorn. . . . . 35 cc.

(continued on next page)

Methyl Salicylate. . . . . 4 cc.
Alcohol. . . . . .65 cc.
Syrup, a sufficient quantity,
To make. . . . . .1000 cc.

438. If you received an order for 2 dozen 2-ounce bottles of tincture of iodine, what quantity of each ingredient would be required to fill the order?

Iodine. . . . . 70 Gm.
Potassium iodide. . . . . 50 Gm.
Distilled water. . . . . 50 cc.
Alcohol, a sufficient quantity,
To make. . . . . 1000 cc.

STOCK SOLUTIONS

Solutions of chemicals are often made so that 1 part of the chemical is contained in a specified number of parts of the solution, as 1 in 10, written 1:10; similarly, we have strengths of 1:25, 1:100, 1:1000, 1:2000, and so on. In pharmaceutical work this method is most frequently used for designating the strengths of weak solutions of potent chemicals, and is generally taken to mean that 1 part, by weight, of the chemical is to be contained in the given number of parts of the solution, by volume, that is, grams in cubic centimeters, or grains in minims, in accordance with the American custom of weighing solids and measuring liquids.

36. TO CALCULATE THE NUMBER OF GRAMS OF A CHEMICAL REQUIRED TO MAKE A GIVEN NUMBER OF CUBIC CENTIMETERS OF A SOLUTION OF SPECIFIED STRENGTH.

439. Example. How much mercuric chloride is required to make 250 cc. of a 1:5000 solution?

$250 \div 5000 = 0.05$ Gm., answer.

or, by ratio and proportion,

$5000:250 = 1:x$
$x = 0.05$ Gm., answer.

Problems

440. How many grams of mercuric chloride are required to make 1200 cc. of a 1:2000 solution?

441. How much mercuric chloride is required to make 500 cc. of a 1:2000 solution?

442. How much mercuric chloride is required to make 600 cc. of a 1:4000 solution?

443. How many grams of mercuric chloride are required to make a liter of a 1:500 solution?

444. How many grams of potassium permanganate are required to make 600 cc. of a 1:250 solution?

445. How many grams of mercury bichloride are required to make 750 cc. of a 1:1000 solution?

To calculate the number of grains of a chemical required to make a given volume of a solution of specified strength.

(Note: Since solutions are very seldom made up in this manner only a few examples will be given.)

446. Example. How many grains of mercuric chloride are required to make 6 fluid ounces of a 1:3000 solution?

480 X 6 = 2880 gr. in 6 fluid ounces.
2880 ÷ 3000 = 0.96 gr., answer.

447. How many grains of mercuric chloride are required to make 12 fluid ounces of a 1:500 solution?

448. How many grains of mercuric chloride are required to make 1 quart of a 1:5000 solution?

449. How many grains of mercuric chloride in 2 quarts of a 1:1000 solution?

Calculation of the amounts of chemicals in stock solutions of various strengths.

450. Example. How many grams of potassium permanganate in 200 cc. of a solution, such that 30 cc. diluted to a liter will give a 1:500 solution?

1 liter = 1000 cc.
1000 ÷ 500 = 2 Gm. in 1 liter of the weak solution, which is also the quantity in 30 cc. of the strong solution.

30 cc.:200 cc. = 2 Gm.:x
x = 13.333 Gm., answer.

or,

200 ÷ 30 = 6.666 portions of 30 cc. each, in the finished product. Each portion of 30 cc. each will make 1000 cc. of the diluted solution, so, 6.666 X 1000 = 6666 cc. = volume of 1:500 solution which can be made from the 200 cc.

500:6666 = 1:x
x = 13.333 Gm., answer.

451. How many grams of copper sulfate are required to make 125 cc. of a solution, 4 cc. of which when diluted to 200 cc. will give a 1:3000 solution?

452. How many grains of mercuric chloride in 8 fluid ounces of a solution, such that 4 fluid drams diluted to a pint will give a 1:5000 solution?

453. How many grams of mercuric chloride will be required to make 240 cc. of a solution, 30 cc. of which diluted to one liter would make a 1:3000 solution?

454. How much potassium permanganate must be used to prepare 2 fluid ounces of a solution of such strength that two teaspoonfuls diluted to a quart will make a 1:2000 solution?

455. Calculate the quantity of mercuric chloride necessary to prepare 4 fluid ounces of a solution of such strength that 1 teaspoonful diluted to one pint will make a 1:300 solution?

456. How much silver nitrate must be taken to prepare 250 cc. of a solution of such a strength that 5 cc. diluted to a liter, constitutes a 1:2500 solution?

37. TRITURATIONS

The Pharmacopoeia gives directions for the manufacture of ten percent triturations. These are convenient for dispensing metric prescriptions and for obtaining decimal fractions of a grain. When common fractional parts of a grain are desired, a strength of 1 in 12 is more convenient.

Triturations are frequently prepared by the pharmacist for use at the prescription counter. Such poisonous substances as strychnine, arsenic, mercury bichloride, atropine, etc., in 10 per cent dilution, are much more accurately dispensed by using this plan, ten times the quantity prescribed being weighed.

457. Example. A prescription calls for 12 capsules each to contain, among other things, 0.002 Gm. of strychnine sulfate. How much of a 1 in 10 trituration should be weighed out?

$$12 \times 0.002 = 0.024 \text{ Gm. strychnine sulfate required.}$$
$$1:0.024 = 10:x$$
$$x = 0.24 \text{ Gm. of the trituration, answer.}$$

or, more simply it may be reasoned, that if 0.024 Gm. is desired and you have a 10 percent trituration, you would need to take 10 times more of the trituration than you would of the pure strychnine sulfate.

$$10 \times 0.024 = 0.24 \text{ Gm. answer.}$$

458. Example. A prescription for 12 pills requires 1/3 grain of strychnine sulfate. How many grains of a 1 in 12 trituration must be taken?

One third of 12 is 4. Hence 4 grains of a 1 in 12 trituration will contain 1/3 of a grain.

12 X 1/3 = 4 gr., answer.

Problems

459. A prescription calls for 20 capsules, each to contain 0.004 Gm. of mercuric chloride. How many Grams must be weighed out if you have a 10 per cent trituration?

460. You are asked to prepare 1 fluid ounce of a 1:1000 solution of atropine sulfate. How much of a 1 in 10 trituration will you weigh out?

461. A prescription calls for 3/4 grain of morphine sulfate. How many grains of a 1 in 12 trituration of morphine must be taken?

462. If 1/6 of a grain of mercuric chloride is desired, how many grains of a 1 in 12 trituration will be required?

463. If a prescription calls for 36 powders, each to contain 0.00015 Gm. of aconitine, how much of a trituration of U.S.P. strength must be taken?

464. If 1/5 of a grain of mercuric chloride is desired, how many grains of a 1 in 10 trituration will be required?

465. It is desired to prepare four fluid ounces of a solution of a drug, of such strength that each teaspoonful will contain 0.003 Gm. How much of a 1 in 10 trituration must be weighed out?

466. How many grams of a 1 in 10 trituration of mercuric chloride will be required to make a quart solution of 1:1000?

467. How many grains of a 1 in 12 trituration will be required to obtain 2/3 of a grain?

38. PERCENTAGE PROBLEMS

468. Example. How many grains of morphine in 2 apothecaries' ounces of opium containing 9.5% of the alkaloid?

9.5% = 0.095
480 X 2 = 960 gr.
960 X 0.095= 91.2 gr., answer.

469. How many grams of alkaloids are there in 60 Gm. of extract of belladonna, containing 1.2% of alkaloids?

470. A certain drug yields 17% of extract. How many grams of extract will be obtained from 500 grams of the drug?

471. How many grams of morphine in 2 avoirdupois pounds of opium, containing 8.2% of the alkaloid?

472. Example. How many grains of morphine alkaloid and of oleic acid are required to make 1 apothecaries' ounce of 12% oleate of morphine?

1 oz. = 480 gr.
480 X 0.12 = 57.6 gr. of morphine alkaloid.
480 - 57.6 = 422.4 gr. of oleic acid, answers.

473. How many grains of cocaine alkaloid are required to make 1 avoirdupois ounce of a 2% ointment?

474. How many grams of tannin and of benzoinated lard are required to make 4 apothecaries' ounces of a 10% tannin ointment?

475. How much iodine is required to make 1 avoirdupois pound of a 4% ointment?

476. How many grams of mercuric chloride are required to make 2 ounces apothecaries' of 2% ointment?

477. How much zinc oxide is required to make $\frac{1}{2}$ avoirdupois pound of 10% ointment?

478. How many grams of phenol crystals are required to make 4 avoirdupois ounces of a 3% ointment?

479. How many grams of salicylic acid are required to make 120 Gm. of a 2.5% ointment?

480. How many grams of mercuric iodide are required to make 25 Gm. of a 0.5% ointment?

481. A recipe calls for 20% of ingredient A, 12% of B, 7% of C, and enough of ingredient D to make 454 grams. How much of each ingredient is required?

482. How much of each ingredient is required to make 1000 Gm. of a cerate containing 35% of resin, 15% of yellow wax, and 50% of lard?

483. How many grains of morphine sulfate are required to make 200 two-grain tablets, each containing 12.5% of the salt?

39. PERCENTAGE SOLUTIONS

The strength of solutions are frequently expressed by percentage and this method is convenient, but it often leads to much confusion and some controversy in this country, because of the American custom of weighing solids and measuring liquids. In European countries, both solids and liquids are weighed, when making percentage solutions, and there is no such confusion.

For the purpose of this course we will follow the instructions given on page 4 of the United States Pharmacopoeia xi, which are as follows:

"In connection with solutions, per cent or percentage has different meanings under different circumstances as follows:

"Per cent or percentage, 'weight in weight' (w/w) expresses the number of grams of an active ingredient in 100 grams of the solution.

"Per cent or percentage, 'weight in volume' (w/v) expresses the number of grams of an active ingredient in 100 cubic centimeters of the solution.

"Per cent or percentage, 'volume in volume' (v/v) expresses the number of cubic centimeters of active ingredient in 100 cubic centimeters of the solution.

"In the dispensing of prescriptions, slight changes in volume due to variations in room temperature and the trifling difference between the volumes of the cubic centimeter and the milliliter are negligible and may be disregarded. When the expression 'per cent' is used in prescriptions without qualification it is to be interpreted to mean: for solutions of solids in liquids, per cent, weight in volume; for solutions of liquids in liquids, per cent, volume in volume; and for solutions of gases in liquids, per cent, weight in volume. For example, a 1 per cent solution is prepared by dissolving 1 gram of a solid or 1 cubic centimeter of a liquid in sufficient of the solvent to make 100 cubic centimeters of the solution. A solution of the same strength may be prepared by apothecaries weight and measure by dissolving 4.5 grains (more accurately 4.5457 grains, at 25° C.) of a solid or 4.8 minims of a liquid in sufficient of the solvent to make 1 fluidounce of the solution."

Problems

484. Example. How should you prepare 250 cc. of a 4% solution of cocaine hydrochloride?

100 cc:250 cc. = 4 Gm.:x

x = 10 Gm., to be dissolved in enough water to make 250 cc., answer.

Another method for solving this problem,

4% = 0.04
250 X 0.04 = 10 Gm., to be dissolved in enough water to make 250 cc., answer.

485. How much boric acid in 30 cc. of a 2% solution?

486. How many grams of phenol in 600 cc. of a 5% solution?

487. How many grams of silver nitrate in 30 cc. of a 15%, weight to volume, solution?

488. How many grams of potassium iodide in 225 cc. of a 20% solution?

489. How much mercuric chloride in 500 cc. of a 1/50% solution?

490. How much atropine sulfate in 120 cc. of a 1/20% solution?

491. Example. How many grains of cocaine hydrochloride in 2 fluidounces of a 4% solution?

1 fluid ounce water = 454.6 gr.
2 X 454.6 = 909.2 gr. in 2 fluidounces water.
4 X 909.2 = 36.36 gr., answer.

492. How many grains of silver nitrate in 6 fluidounces of a 7½% solution?

493. How many grains of cocaine hydrochloride in 2 fluidounces of a 2% solution?

494. How many grains of boric acid in 1 pint of a 1% solution?

495. How many grains of cocaine hydrochloride in 4 fluidounces of a 6% solution.

496. How many grains of boric acid in 8 fluidounces of a 2% solution?

497. How many grains of phenol in 8 fluidounces of a 6% solution?

498. How many grains of cocaine hydrochloride in 3 fluidounces of a 3% solution?

499. How many grains of potassium permanganate in 4 fluidounces of a 1/10% solution?

500. How many grams of eserine sulfate in 30 cc. of a 0.25% solution?

501. How many grains of iodine in 8 fluidounces of a ½% solution?

502. Example. How many grams of atropine sulfate in 1 fluidounce of a 1% solution?

1 fluidounce = 29.57 cc.
29.57 X 0.01 = 0.2957 Gm. answer.

503. How many grams of boric acid in 1 gallon of a 2% solution?

504. How many grams of cocaine hydrochloride in 6 fluidounces of a 3% solution?

505. How many grains of silver nitrate in 3 fluid drams of a 3½% solution?

506. How many grams of phenol in 12 fluidounces of a 4% solution?

507. How many grains of morphine sulfate in 4 fluidounces of a 5% solution?

508. How many grams of silver nitrate in 3 fluidounces of a 6% solution?

509. How many grains of a chemical in 2 fluidounces of a 7.5% solution?

510. How many grams of silver nitrate in 4 fluidounces of an 8% solution?

511. How many grains of potassium bromide in 2 fluidounces of a 10% solution?

512. How many grams of silver nitrate in 4 fluidounces of a 12% solution?

513. How many grains of mild silver protein in ½ fluidounce of a 15% weight to volume solution?

514. How many grams of potassium iodide in 1 fluidounce of a 20% weight to volume solution?

515. How much atropine sulfate in ½ fluidounce of a ½% solution?

516. How many grams of boric acid in ½ gallon of a 3% solution?

517. How many grains of iodine in 6 fluidounces of a 2% solution?

518. How many grains of silver nitrate must be taken to make one fluidounce of a 0.02% solution?

519. How many grains of physostygmine salicylate will be required to make one fluidounce of a 2% solution?

520. How much carbolic acid must be taken to prepare a half ounce of 5% carbolated oil?

521. How many grams of atropine sulfate are required to make 2 fluid ounces of a 1/10% solution?

522. How many grams of silver nitrate are required to make 6 fluid ounces of $\frac{1}{4}$% solution?

523. How many grains of atropine sulfate are required to make 60 cc. of a 1% solution?

524. How many grains of mercuric chloride are required to make 500 cc. of a $\frac{1}{2}$% solution?

525. How many grains of silver nitrate are required to make 400 cc. of a 1% solution?

526. How many grains of boric acid are required to make 190 cc. of a 2% solution?

527. How many grains of cocaine hydrochloride are required to make 250 cc. of a 4% solution?

528. How many grains of silver nitrate are required to make 120 cc. of a 5% solution?

529. How many grains of each active ingredient are required to make 6 fluidounces of a solution, to contain 2% of boric acid and 5% of glycerine?

530. How many grains of each active ingredient, are required to make 8 fluidounces of a solution, to contain 2% of cocaine hydrochloride and 3% of glycerine?

531. How many grains of each active ingredient are required to make 3 fluid ounces of a solution, to contain 3% of boric acid and 2% of sodium chloride?

532. How many grains of each active ingredient are required to make 3 fluid ounces of a solution, to contain 3% of cocaine hydrochloride and 0.5% of phenol?

533. How many grains of each active ingredient are required to make 8 fluid ounces of a solution, to contain 3% of boric acid

and 5% of glycerine?

534. How many grains of each active ingredient in 4 fluid ounces of a solution containing 2% of boric acid and 1:2000 of mercuric chloride?

535. How many grams of each active ingredient in 1000 cc. of a solution containing 3% of boric acid and 8% of glycerine?

The commonly used recipe for a nucleus or primary emulsion is oil-4 parts, water-2 parts, and acacia-1 part, or $\frac{1}{2}$ as much of water and $\frac{1}{4}$ as much of acacia as of oil, liquids by volume and the acacia by weight, in corresponding units.

536. Example. How much oil, water, and acacia are required to make the nucleus for 8 fluid ounces of an emulsion, to contain 40% of oil?

40% = 0.4
8 X 0.4= 3.2 fluid ounces of oil.
3.2 X 1/2 = 1.6 fluid ounces of water.
3.2 X 1/4 = 0.8 ounces of acacia.

3.2 fluid ounces = 3 fluid ounces, 1 fluid dram, 36 minims of oil.
1.6 fluid ounces = 1 fluid ounce, 4 fluid drams, 48 minims of water.
0.8 ounces = 6 drams, 24 grains of acacia, answers.

537. How much oil, water, and acacia are required to make the nucleus for 1 pint of an emulsion, to contain 50% of oil?

538. How much oil, water and acacia are required to make the nucleus for 6 fluid ounces of an emulsion to contain 25% of oil?

539. How much oil, water, and acacia are required to make the nucleus for 250 cc. of an emulsion, to contain 30% of oil?

540. How much oil, water and acacia are required to make the nucleus for 120 cc. of emulsion, to contain 35% of oil?

541. Example. If 5 Gm. of cinchona contain 275 mg. of alkaloids, what is the per cent of alkaloids?

275 mg. = 0.275 Gm.
5 Gm.:0.275 Gm. = 100%:x
x = 5.5%, answer.

542. If 8 dg. of belladonna root yield 56 mg. of ash, what is the percentage of ash?

543. Example. If 1450 Gm. of a solution of mercuric chloride contain 100 Gm. of the salt, what is the percentage strength of the solution?

Example: 1450 Gm.:100 Gm. = 100%:x
x = 6.89 + %, answer.

544. If 1900 Gm. of a solution of strontium salicylate contain 100 Gm. of the salt, what is the percentage strength of the solution?

545. Example. What is the percentage strength of a solution of 62.5 Gm. of potassium iodide in 187.5 cc. of water?

187.5 cc. of water = 187.5 Gm.
62.5 + 187.5 = 250 Gm. of solution.
250 Gm.:62.5 Gm. = 100%:x
x = 25%, answer.

546. If 1 Gm. of potassium chlorate will dissolve in 11.5 cc of water, what is the percentage strength of the solution?

547. If 3 Gm. of potassium iodide are dissolved in 27 cc. of water, what is the percentage strength of the solution?

548. If 50 Gm. of potassium iodide are dissolved in 1000 cc. of water, what is the percentage strength of the solution?

549. If 850 Gm. of sugar are dissolved in 1000 cc. of water, what is the percentage strength of the solution?

550. If 30 Gm. of camphor are dissolved in 180 Gm. of alcohol, what is the percentage strength of the solution?

551. Example. If 1 dram of cocaine hydrochloride is dissolved in 3 fluid ounces of water, what is the percentage strength of the solution?

455 X 3 = 1365 gr. of water.
1 dram = 60 gr. of cocaine hydrochloride
1365 + 60 = 1425 gr. of solution.
1425 gr.:60 gr = 100%:x
x = 4.21 + %, answer.

552. What is the percentage strength of a solution containing 65 gr. of silver nitrate dissolved in 400 gr. of water?

553. What is the percentage strength of a solution of 28 gr. of potassium hydroxide in 350 gr. of water?

554. If 1 part of water dissolves 1.5 parts of potassium iodide, what is the percentage strength of the solution?

555. Example. How much of cocaine hydrochloride and of water are required to make 2 apothecaries' ounces of a 3% solution?

Example: 480 x 2 = 960 gr.
960 X 0.03 = 28.8 gr. of cocaine hydrochloride.
960 - 28.8 = 931.2 gr.
= 1 ounce 7 drams, 31.2 gr. of water, answer.

556. How many grains of cocaine hydrochloride are required to make 750 grains of a 4% solution?

557. What quantities of sugar and of water are required to make 15 avoirdupois pounds of a 60% syrup?

558. How much of silver nitrate and of water are required to make 30 Gm. of a 25% solution?

559. How many avoirdupois ounces of camphor are required to make a kilogram of camphorated oil, which is a 20% solution by weight?

560. Example. How much potassium iodide should be added to 10 apothecaries' ounces of water to make a 15% solution, and what will be the total weight of the solution?

100% - 15% = 85% of water.
85%:15% = 10 ounces:x
x = 1.764 ounces.
= 1 ounce, 6 drams, 6 + gr. of potassium iodide.
10 ounces + 1 ounce 6 drams 6 + gr. = 11 ounces 6 drams, 6 + gr., total weight, answers.

561. How many grains of boric acid should be added to 4 fluid ounces of glycerine to make a 5% solution?

562. How many grams of silver nitrate should be dissolved in 60 cc. of water to make a 20% solution?

563. How many grams of potassium iodide should be dissolved in 90 cc. of water to make a 12% solution?

564. How many grams of zinc sulphate should be added to 240 Gm. of water to make a 4% solution?

565. Example. How should you dispense 6 fluid ounces of a 20% by weight, solution of silver nitrate?

455 X 6 = 2730 gr. in 6 fluid ounces of water.
100% - 20% = 80% of water.
80% : 20% = 2730 gr.:x
x = 682.5 gr. of silver nitrate, plus 6 fluid ounces of water, answer.

566. How should you dispense 3 fluid ounces of a 6%, by weight, solution of silver nitrate?

567. How should you dispense 4 fluid ounces of an 8%, by weight, solution of silver nitrate?

568. How should you dispense 3 fluid ounces of a 10%, by weight, solution of mild silver protein?

569. How should you dispense 2 fluid ounces of a 12%, by weight, solution of silver nitrate?

570. How should you prepare 6 fluid ounces of a 16%, by weight, solution of silver nitrate?

571. Example. How should you prepare 2 fluid ounces of a 20%, by weight, solution of mild silver protein?

455 X 2 = 910 gr. in 2 fluid ounces of water.
100 - 20 = 80% of water.
80%:20% = 910 gr.:x
x = 227.5 gr. mild silver protein, plus 2 fluid ounces of water, answer.

572. How should you prepare 4 fluid ounces of a 12%, by weight, solution of silver nitrate?

573. How should you prepare 3 fluid ounces of a 20%, by weight, solution of potassium iodide?

574. How should you prepare 4 fluid ounces of a 16%, by weight, solution of potassium iodide?

575. How should you prepare 2 fluid ounces of a 25%, by weight, solution of silver nitrate?

576. How should you prepare 4 fluidounces of a solution to contain 3% of boric acid and 10% of glycerin, by weight?

It is the custom for pharmacists to dispense percentage solutions by the weight to volume method, in most parts of the United States, and it is believed that such solutions are generally wanted by physicians when they prescribe percentage solutions. It will emphasize the difference between these solutions and true percentage solutions if the following problems are solved both ways.

577. Example. How should you prepare 4 fluidounces of a 10% solution of potassium bromide?

Weight to volume:

480 X 0.1 = 48 grains in 1 fluidounce of 10% solution.
48 X 4 = 192 grains, plus sufficient water to make 4 fluidounces, answer.

True percentage by weight:

Example: 455 X 4 = 1820 gr. in 4 fluidounces of water.
100 -10 = 90% of water.
90%:10% = 1820 gr.:x
x = 202 gr., plus 4 fluidounces of water, answer.

578. How should you prepare 2 fluidounces of a 1% solution of atropine sulfate?

579. How should you prepare 6 fluidounces of a 3% solution of boric acid?

580. How should you prepare 8 fluidounces of a 6% solution of strong silver protein?

581. How should you prepare 3 fluidounces of an 8% solution of silver nitrate?

582. How should you prepare 2 fluidounces of a 10% solution of potassium iodide?

583. How should you prepare 2 fluidounces of a 12% solution of silver nitrate?

584. How should you prepare ½ fluidounce of a 15% solution of mild silver protein?

585. How should you prepare 4 fluidounces of a 25% solution of silver nitrate?

To calculate the quantity of a percentage solution that can be made from a given weight of a chemical.

In pharmaceutical work, such solutions are generally calculated on a weight to volume basis, as follows:

586. Example. What volume of a 2% solution of cocaine hydrochloride can be made from 1/8 oz. of the salt?

437.5 X 1/8 = 54.68 gr. in 1/8 oz.
2 gr.:54.68 gr.= 100 m:x
x = 2734 minims
= 5 fluidounces, 5 fluidrams, 34 minims., answer.

587. What volume of a 5% solution can be made from 4 drams of a salt?

588. What volume of a 5% solution can be made from 170 grains of silver nitrate?

589. What volume of a 3% solution can be made from 200 grains of strong silver protein?

590. What volume of a 10% solution can be made from 125 grains of mild silver protein?

591. What volume of a 2% solution can be made from 1/8 ounce of the salt?

592. What volume of a 1% solution can be made from 27 gr. of strong silver protein?

593. How many cubic centimeters of a 3% solution can be made from 27 Gm. of a chemical?

594. How many cubic centimeters of 7% tincture can be made from 113 Gm. of iodine?

595. How many cubic centimeters of a 4% solution of cocaine can be made from 1/8 oz. of the salt?

596. How many cubic centimeters of a 10% solution can be made from $\frac{1}{4}$ oz. of mild silver protein?

597. How many fluid ounces of a $\frac{1}{2}$ solution of atropine sulfate can be made from 1 Gm. of the salt?

To calculate the quantity of solvent required to make a percentage solution with a given weight of chemical.

598. Example. How many cubic centimeters of water should be used to dissolve 3.54 Gm. of cocaine hydrochloride to make a 2% solution?

100% - 2% = 98% water.
2%:98% = 3.54:x
x = 173.46 Gm. or cc., answer.

599. How many cubic centimeters of water should be used to dissolve 4 Gm. of mercuric chloride to make a 1/10% solution?

600. What volume of water should be added to 1 oz. of pure potassium iodide to make a 30%, by weight, solution?

40. ALLIGATION MEDIAL

To calculate the percentage strength of a mixture of different amounts of solutions, or other preparations, of different percentage strengths.

601. Example. What is the percentage of alcohol in a mixture of 600 cc. of 78% alcohol, 1500 cc. of 42% alcohol, and 800 cc. of 35% alcohol?

78 X 600 = 46800
42 X 1500 = 63000
35 X 800 = 28000
2900 137800

137800 ÷ 2900 = 47.51%, answer.

By this method of solution, each percentage strength is multiplied by the corresponding quantity, and the sum of the products is divided by the sum of the quantities, the result being the percentage strength of the mixture. The quantities may be expressed in any unit of weight or measure, but the unit must be the same throughout a given problem.

602. What is the percentage of alcohol in a mixture of 1500 cc. of 60% alcohol, 400 cc. of 40% alcohol, and 500 cc. of 50% alcohol?

603. What is the percentage of alcohol in a mixture of 1 fluidounce of a fluid extract containing 60% of alcohol, 1 fluidounce of a fluid extract containing 40% of alcohol, 2 fluidounces of a tincture containing 30% alcohol, and 8 fluidounces of an elixir containing 25% of alcohol?

604. What is the percentage of alcohol in a mixture of 12 fluidounces of 70% alcohol, 15 fluidounces of 95% alcohol, and 8 fluidounces of 60% alcohol?

605. What is the percentage of alcohol in a mixture of 5 pints of 83% alcohol, 8 pints of 42% alcohol, and 11 pints of 18% alcohol?

606. Example. What is the percentage of alcohol in a mixture of 3 lb. of 65% alcohol, 7 lb. of 32% alcohol, and 12 lb. of 57% alcohol?

$$65 \times 3 = 195$$
$$32 \times 7 = 224$$
$$57 \times \underline{12} = \underline{684}$$
$$22 \quad 1103$$
$$1103 \div 22 = 50.13 + \%, \text{ answer.}$$

607. What is the percentage of alcohol in a mixture of 3 lb. of 90% alcohol, 7 lb. of 40% alcohol, and 12 lb. of 62% alcohol?

608. A manufacturer has three lots of alcohol recovered from percolation: 21 lb. of 80%, 35 lb. of 91%, and 41 lb. of 45%. What will be the percentage strength of a mixture of the three lots?

609. What is the percentage of ammonia in a mixture of 4 lb. of 7.4% ammonia water, 3 lb. of 9.6% ammonia water, and 5 lb. of 6.7% ammonia water?

610. What is the percentage of ammonia in a mixture of 4 lb. of 28% ammonia water, 7 lb. of 6% ammonia water, and 3 lb. of 4% ammonia water?

611. Find the percentage strength of a mixture of 3 lb. of 6% ammonia water, 7 lb. of 8% ammonia water, and 4 lb. of 27% ammonia water.

612. What is the percentage of alkaloids in a mixture of 30 lb. of cinchona containing 5.62% of alkaloids, 16 lb. containing 4.35% of alkaloids, and 42 lb. containing 6.47% of alkaloids?

613. If two lots of cinchona, one consisting of 500 lb. containing 3.3% of quinine, and the other consisting of 300 lb. containing 2.1% of quinine, are mixed, what is the percentage of quinine in the mixture?

614. Lots of cinchona bark are mixed as follows: 24 lb. containing 3.5% of quinine, 16 lb. containing 2.2% of quinine, and 8 lb. containing 1.9% of quinine. What is the percentage of quinine in the mixture?

615. If 50 Gm. of opium containing 9% of morphine, 75 Gm. containing 10% and 100 Gm. containing 12% are mixed, what is the percentage of morphine in the mixture?

616. What is the morphine strength of a mixture of 10 Kg. of opium containing 14% of morphine, 12 Kg. containing 9%, and 17 Kg. containing 5%?

617. Find the percentage of morphine in a mixture of 2 lb. of opium containing 9% of morphine, 5 lb. containing 12%, and 3/4 lb. containing 16%.

618. What is the percentage strength of a mixture of 100 Gm. of 4% acetic acid, 60 Gm. of 6% acetic acid, 85 Gm. of 5% acetic acid, and 40 Gm. of 10% acetic acid?

619. A druggist has 10 lb. of a mixture of 40% sulphur and 60% cream of tartar, 5 lb. containing equal parts of sulphur and cream of tartar, and 5 lb. containing 30% sulphur and 70% cream of tartar, which he mixes together. What is the percentage of sulphur in the mixture?

In some problems the addition of a solvent or vehicle must be considered. In such problems it is generally best to consider the diluent as of zero percentage strength, as in the following problem.

620. Example. What is the percentage of alcohol in a mixture of 135 cc. of a fluid extract containing 18% of alcohol, 35cc. of a fluid extract containing 60% of alcohol, 35 cc. of a fluid extract containing 40% of alcohol, 65 cc. of 95% alcohol, and sufficient syrup to make 500 cc.?

$$135 + 35 + 35 + 65 = 270$$

500 - 270= 230 cc. of syrup.

$$18 \times 135 = 2430$$
$$60 \times 35 = 2100$$
$$40 \times 35 = 1400$$

(Continued on next page)

$$\begin{array}{rr} 95 \times 65 = & 6175 \\ 0 \times 230 = & 0 \\ \hline 500 & 12105 \end{array}$$

$12105 \div 500 = 24.21\%$, answer.

621. What is the percentage of alcohol in a mixture of 3 lb. of 80% alcohol, 8 lb. of 91% alcohol, 5 lb. of 45.5% alcohol, 6 lb of 40% alcohol, and 8 lb. of water?

622. Suppose a solution of 10% strength is mixed with an equal weight of a solution of 20% strength and this mixture is reduced by an equal weight of solvent; what will be the percentage strength of the mixture?

623. A manufacturer has recovered 5 gallons of 92 per cent alcohol, 8 gallons of 60 per cent, 3 gallons of 30 per cent and 2 gallons of 75 per cent. What is the strength of the mixture?

624. If you compound a mixture containing 2 ounces of a drug that cost $5.60 a pound; 4 ounces of another that cost 64 cents a pound; 6 ounces of another that cost 56 cents a pound; and 5 ounces that cost 40 cents a pound, what is the average cost per ounce?

625. If a powder contains 40 grains of a drug that cost 60 cents an ounce, 60 grains at 8 cents an ounce, and 90 grains at $1.20 an ounce, what will one dram of the mixture cost?

626. Four equal amounts of cinchona, containing 4,6,5,8,5, and 10 per cent of total alkaloids respectively, were mixed. What was the strength of the mixture?

627. A pharmacist in the process of manufacture recovers a quart of 45 per cent alcohol, a pint of 60% alcohol, 30 ounces of 75% alcohol, and 20 oz. of 35 per cent alcohol. When these were mixed what was the strength of the mixture?

628. Three samples of opium are mixed, the first consisted of 5 oz. of 8 per cent morphine, the second 6 oz. of 9%, the third 4 oz. of 12%. What is the strength of the mixture?

To calculate the specific gravity of a mixture of different quantities of liquids of known specific gravities:

The method used in the above percentage problems can be applied to specific gravities of liquids if there is no contraction in volume when the liquids are mixed.

629. Example. What will be the specific gravity of a mixture of 4 lb. of ammonia water, specific gravity = 0.917; 6 lb., specific gravity = 0.954; and 3 lb., specific gravity = 0.928?

Example. 0.917 X 4 = 3.668
0.954 X 6 = 5.724
0.928 X 3 = 2.784
13 12.176

12.176 ÷ 13 = 0.936, answer.

630. What will be the specific gravity of a mixture containing 4 fl. oz. of sulphuric acid, sp. gr. 1.652, 6 fl.oz., 1.253, 7 fl. oz., sp. gr. 1.165?

41. ALLIGATION

The application of the principles of alligation to the practice of pharmacy admits of extended use.

Alligation, as applied to pharmacy, is the method of ascertaining the quantities of substances of different strengths required to be mixed in order to produce a certain mixture of a given strength.

Every alligation problem must contain a higher or a stronger term to be mixed with a lower, or a weaker term to produce one of intermediate or required strength.

Alligation Applied to Pharmacy.

631. Example. In what proportion must 12 per cent and 17 per cent powdered opium be mixed to produce a 14 per cent opium?

As we are to obtain an intermediate strength we first find what part of each must be taken, so that the gain and loss will each equal one unit.

Since 14 per cent is required, if one part of 17 per cent and one part of 12 per cent are mixed the increase in strength in one case is 3 per cent and the decrease in strength in the other is 2 per cent. Therefore to make the increase and decrease equal, 1/3 of a part of 17 per cent must be taken to gain 1 per cent, and 1/2 of a part of 12 per cent must be taken to decrease the strength 1 per cent. Hence, if 1/3 of a part of 17 per cent and 1/2 of a part of 12 per cent are mixed, a 14 per cent opium will be made.

As the fractions are proportional parts we may take any number of times 1/3 and 1/2, if both terms are multiplied by the same number, and the strength of the product will not be changed. Advantage is taken of this fact in the changing of the fractions to whole numbers. This is done by multiplying the fractions by the least common multiple of their denominators, which is 6. We then have:

$$14 \left| \begin{array}{l|l} 17 & 1/3 \times 6 = 2, \text{ 2 parts of 17\% opium} \\ 12 & 1/2 \times 6 = 3, \text{ 3 parts of 12\% opium} \end{array} \right.$$

Make 5 parts of 14% opium

From the preceding we derive the following:

Find the quantity, the strength of which is greater than the mean rate, that must be taken to gain one of the same denomination as the mean rate. Find the quantity, the strength of which is less than the mean rate, that must be taken to lose one of the same denomination as the mean rate. Change the fractions, if there are any, to whole numbers. The result is the number of parts of each that must be taken to produce the mean rate.

632. In what proportion must a 6 per cent and a 14 per cent drug be mixed to produce one of 8 per cent?

633. In what proportion must 92 per cent alcohol and 20 per cent alcohol be mixed to produce 40 per cent alcohol?

634. Mix 8 per cent and 28 per cent ammonia water to make 10 per cent ammonia water.

635. In what proportion must 28 per cent ammonia water and water be mixed to produce 10 per cent ammonia water?

636. In what proportion must 28 and 16 per cent hydrochloric acid be mixed to produce 18 per cent?

637. In what proportion must lactose be added to 18 per cent opium to reduce it to 12 per cent?

638. In what proportion must 98 per cent phenol be mixed with water to reduce it to 88 per cent?

639. If two samples of opium contain, respectively 16 and 11 per cent of morphine, in what proportion must they be mixed to produce a 14 per cent opium?

640. In what proportion must glycerin be added to 88 per cent liquid phenol to reduce it to 18 per cent?

641. In what proportion must 4 per cent cinchona be mixed with 7 per cent cinchona to reduce the latter to 5 per cent?

642. If two samples of drug cost 65 and 85 cents a pound, in what proportion must they be mixed to produce a mixture costing 72 cents a pound?

643. A 60 per cent menstruum is desired. In what proportion must 45 and 82 per cent alcohol be used?

In the demonstration of the preceding example observe that the number in the final result, in each case, is the same as the figure of the denominator of the fraction of the substance with which it is to be mixed. From which we deduce the following:

Subtract the required per cent from the greater per cent and place the difference opposite the lower per cent. Also subtract the lower per cent from the required per cent and place the difference opposite the greater per cent. The figures opposite each are the required result.

Thus:	14	17	2,	2 parts of 17%
		12	3,	3 parts of 12%
				5 parts of 14%

When per cent by weight is used, the proportionate parts are by weight. When per cent by volume is used, the proportionate parts are by volume.

When mixing liquids by measure that contract in volume when mixed, they should be allowed to stand until contraction ceases. Then add sufficient quantity of the diluent to make the required volume.

644. Example. In what proportion should two lots of cinchona bark containing 4.6% and 6.1% of alkaloids, respectively, be mixed to make a mixture containing 5.2% of alkaloids?

5.2%	4.6%	0.9	9 parts
	6.1%	0.6	6 parts

The first ratio is 0.9:0.6, but this is multiplied through by 10 to get the whole number 9:6, answer.

645. Two lots of cinchona bark contain 1.7 and 2.8% of quinine, respectively. In what proportion should they be taken to make a mixture containing 2.1% of quinine?

646. In what proportion should 0.38% and 1.2% solutions be mixed to make a 0.5% solution?

647. Example. In what proportion must 8, 10, 16, and 18 per cent opiums be mixed to form a 14 per cent opium?

Write the per cents in a column. Connect each one of the terms which is less than that of the required term with one that is greater. Solve each couplet as before.

14	8	4	2,	2 parts of 8 per cent opium
	10	2	1,	1 part of 10 per cent opium
	16	4	2,	2 parts of 16 per cent opium
	18	6	3,	3 parts of 18 per cent opium

When solving the above problem by the first method, the fractions in each couplet should be changed to whole numbers separately.

Thus:

	A	B	C	D	E
14	8	1/6		2	
	10		1/4		1
	16		1/2		2
	18	1/4		3	

Multiplying B by the least common multiple of its denominators, which is 12, we have D. Multiplying C by the least common multiple of its denominators which is 4, we have E.

When an odd number of substances are used, or when the number of weaker per cents exceed the stronger, or vice versa, some of the terms must be used more than once.

Thus:

Example. In what proportion must 8, 16, and 18 per cent opiums be mixed to form a 14 per cent opium?

14	8	2	4	6	1 part of 8% opium)
	16	6		6	1 part of 16% opium) = 3 parts of
	18		6	6	1 part of 18% opium) 14% opium

648. Example. Find the relative amounts of different lots of nux vomica, containing 5.42%, 5.16%, and 4.38% of strychnine, respectively, that should be taken to make a mixture containing 4.8% of strychnine.

4.8%	5.42%	0.42	42 parts
	5.16%	0.42	42 parts
	4.38%	0.36 + 0.62 = 0.98	98 parts

The one lot containing less than the required percentage is linked to each of the lots containing more than the required percentage, and the relative quantities of each pair is obtained by subtraction as in the preceding problems. The two amounts of the 4.38% lot are then added together to get the total quantity of this lot. The continued ratio 0.42:0.42:0.98 is finally multiplied through by 100 to get rid of decimals, giving the answer 42:42:98.

649. In what proportion should three lots of ammonia water containing 7%, 16%, and 18% of ammonia, respectively, be mixed to obtain a mixture containing 11% of ammonia?

650. Three lots of ground cinchona contain 2%, 6%, and 7% of alkaloids, respectively. In what proportion should they be

taken to make a mixture containing 4% of alkaloids?

651. What relative amounts of alcohols of 91%, 24% and 18% strength, respectively, should be taken to make 41% alcohol?

652. A pharmacist has 400 grams of opium containing 10 per cent of morphine, 350 grams of opium containing 12 per cent of morphine. How much opium of 16% morphine must he add to a mixture of the two to make a product containing 13% of morphine?

653. If 5 pounds of cinchona containing 7% of quinine is mixed with 3 pounds of cinchona containing 8.4% of quinine, how much cinchona, containing 4.5% of quinine, must be added to the mixture to reduce it to 6 per cent?

654. In what proportion must 50%, 35% acid and water be mixed to produce a 10% acid?

655. In what proportion must three samples of cinchona be mixed to produce a mixture containing 5% of quinine, if the samples contain 6.44, 4.48 and 3.68 percent of quinine?

656. If two samples of opium containing 14.5 and 16 per cent of morphine are mixed, in what proportion must lactose be added to reduce the mixture to 12 per cent?

657. Example. Find the relative amounts of different lots of ammonia water containing 4.6%, 8.4%, 16.7%, and 28%, respectively, that may be mixed to make 10% ammonia water.

10%	4.6%	18.0	180 parts
	8.4%	6.7	67 parts
	16.7%	1.6	16 parts
	28.0%	5.4	54 parts

10%	4.6%	6.7	67 parts
	8.4%	18.0	180 parts
	16.7%	5.4	54 parts
	28.0%	1.6	16 parts

Since two are weaker and two stronger than that which is required, the given lots should be paired in two ways, resulting in two sets of answers, 180:67:16:54 or 67:180:54:16.

658. In what proportions should lots of alcohol of 15%, 35%, 60%, and 82% strength, respectively, be mixed to make 50% alcohol?

659. In what proportion should lots of opium containing 6%, 10%, 13%, and 16% of morphine, respectively, be mixed to make a mixture containing 13.5% of morphine?

To find the quantities of solutions, or other mixtures, of different percentage strengths that should be used to make a required quantity of a solution, or other mixture, of given percentage strength:

660. Example. How many ounces of 12 and 18 per cent powdered opiums are required to make 24 ounces of 14 per cent opium?

14	18	2	1 part of 18% opium
	12	4	2 parts of 12% opium
			3 parts of 14% opium

Since the sum of the parts is 3, to make 24 ounces we must take as many times the number of parts of each as 3 is contained in 24, which is 8.

8 X 1 = 8, or 8 oz. of 18% opium.
8 X 2 = 16, or 16 oz. of 12% opium.

8 + 16 = 24 ounces of 14% opium.

Or by proportion,

3 : 24 : : 1 : x, x = 8 oz. of 18% opium.
3 : 24 : : 2 : x, x = 16 oz. of 12% opium.

661. How many grams of 16% and 10% opiums must be used to make a kilogram of 14% opium?

662. How many grams of lactose must be mixed with a 25% triturate to produce 10 grams of a 10% triturate?

663. How many cubic centimeters of 92% and 40% alcohol will be required to make 2 liters of 50% alcohol?

664. How many cubic centimeters of 12% alcohol and of 84% alcohol should be mixed to make 1500 cc. of 60% alcohol?

665. How many cubic centimeters of 95% alcohol and of 37% alcohol should be mixed to make 1000 cc. of 51% alcohol?

666. How many grams of 25% ammonia water and of 7% ammonia water should be mixed to make 3000 Gm. of 10% ammonia water?

667. How many pounds of 28% ammonia water and of 8% ammonia water should be mixed to make 12 pounds of 10% ammonia water?

668. How many grams of 85% phosphoric acid and of 10% phosphoric acid should be mixed to make 1000 Gm. of 38% phosphoric acid?

669. How many grams of opium containing 8.6% of morphine and of opium containing 11.3% of morphine should be mixed to obtain 300 Gm. of opium containing 10.2% of morphine?

To calculate the quantity of a solution, or other mixture, of given percentage strength that should be mixed with a specified quan-

tity of another solution, or other mixture, of given percentage strength to make a mixture of required percentage strength:

670. Example. How many ounces of lactose must be mixed with 20 ounces of a 12% triturate to make a 5% triturate?

$$5 \cdot \left|\begin{array}{c|c} 12 & 5 \\ 0 & 7 \end{array}\right\| \; 20 \div 5 = 4$$

Seven parts of lactose are required for every five parts of triturate; as there are 20 parts of triturate it will require 4 X 7, or 28 parts of lactose.

Or by proportion: 5 : 20 : : 7 : x, x = 28.

671. How many avoirdupois ounces of water must be added to 30 avoirdupois ounces of 25% nitric acid to produce a 5% nitric acid?

672. How many grams of 20% alcohol must be added to 1000 grams of 80% alcohol to make a 55% alcohol?

673. Given 10 apothecaries' ounces of 91% alcohol, to make a 45.5% alcohol. How many ounces of 20 per cent alcohol are required?

674. How many ounces of 92% alcohol must be added to 100 ounces of 30% alcohol to make a 50% alcohol?

675. Given 25 ounces of 15% alcohol to make 45% alcohol. How many ounces of 85% alcohol are required?

676. How many pints of 94% alcohol should be mixed with 8.5 pints of 32% alcohol to make 50% alcohol?

677. How many pounds of 91% alcohol should be mixed with 10 lb. of 30% alcohol to make 41% alcohol?

678. How many grams of 41% alcohol should be mixed with 6375 Gm. of 92% alcohol to make 70% alcohol?

679. How many fluid ounces of 95% alcohol should be added to 10 gal. of extract of witch hazel containing 12% of alcohol to make a mixture containing 15% of alcohol?

680. How many grams of 92% sulphuric acid should be mixed with 1200 Gm. of 12% sulphuric acid to make 40% acid?

681. How many grams of 10% sulphuric acid should be mixed with 300 Gm. of 92.5% sulphuric acid to make 20% acid?

682. How many ounces of 99% acetic acid should be mixed with 8 lb. of 30% acetic acid to make 36% acid?

683. How many grams of 68% nitric acid should be mixed with 325 Gm. of 12% nitric acid to make 30% acid?

684. How many grams of 10% hydrochloric acid should be mixed with 454 Gm. of 32% hydrochloric acid to make 20% acid?

685. How many pounds of 28% ammonia water should be mixed with 8.5 lb. of 7.35% ammonia water to make 10.2% ammonia water.

686. Example. How many grams of opium containing 12.5% of morphine should be mixed with 125 Gm. containing 8.8% of morphine to make a mixture containing 10.1% morphine?

	12.5%	1.3	13 parts
10.1%			
	8.8%	2.4	24 parts

24 parts : 13 parts = 125 Gm. : x

x = 67.70 + Gm., answer.

687. How many grams of opium containing 14% of morphine should be mixed with 600 Gm. containing 7% of morphine to make a mixture containing 9.5% of morphine?

688. How many grams of opium containing 12.5% of morphine should be mixed with 1400 Gm. containing 7.8% of morphine to make a mixture containing 10.6% of morphine?

689. How many grams of cinchona containing 6.7% of alkaloids should be mixed with 3620 Gm. containing 4.3% of alkaloids to make a mixture containing 5.1% of alkaloids?

690. How many pounds of jalap containing 8.4% of resin should be mixed with 12 lb. containing 6.2% of resin to make a mixture containing 7.1% of resin?

691. How many grams of scammony containing 7.3% of resin should be mixed with 2000 Gm. containing 9.2% of resin to make a mixture containing 8% of resin?

692. How much extract of nux vomica containing 19.4% of alkaloids should be mixed with 760 Gm. containing 13.2% of alkaloids to make a mixture containing 16% of alkaloids?

693. How many grams of opium containing 12.3% of morphine should be mixed with 1800 Gm. containing 8.9% of morphine to make a mixture containing 10.2% of morphine?

694. Example. How many pints of 95% alcohol should be mixed with 6 pt. of 58%, 12 pt. of 22%, and 8 pt. of 16% alcohol to make 45% alcohol?

First consider that the three given lots are mixed.

58 X 6 = 348
22 X 12 = 264
16 X 8 = 128
26 740

740 ÷ 26 = 28.46 + %

26 pints of 28.46% alcohol.

	28.46%	50 parts
45%		
	95%	16.54 parts

50 parts : 16.54 parts = 26 pt. : x

x = 8.59 + pt., answer.

695. How many pints of 95% alcohol should be mixed with 5 pt of 26% and 8 pints of 41% alcohol to make 50% alcohol?

696. How many pounds of 91% alcohol should be mixed with 4 lb. of 21% and 7 lb. of 35% alcohol to make 41% alcohol?

697. How many fluid ounces of 95% alcohol should be mixed with 37 fluid ounces of 36% and 93 fluid ounces of 24% alcohol to make 45% alcohol?

698. How many cubic centimeters of 95% alcohol should be mixed with 2200 cc. of 22% and 1250 cc. of 36% alcohol to make 50% alcohol?

699. A druggist has three lots of alcohol recovered from percolation: 5.5 lb. of 12%, 7.125 lb. of 26%, and 4 lb. of 18%. How many pounds of 91% alcohol should be mixed with them to make 41% alcohol?

700. How many grains of 18% opium must be mixed with 50 grains of 12%, 80 grains of 13%, and 40 grains of 10% opiums to make powdered opium containing 14% morphine?

CALCULATION OF DOSAGE

Calculate the Dose of Each of the Medicinal Ingredients in the Following Prescriptions:

701. Rx
Hydrargyri Chloridi Mitis 0.75
Sucrosi 2.00
M. ft. Chart. vi.
Sig. - One at night.

702. Rx
Acidi Boracici 5.0
Aquae Distillatae 60.0
M. Ft. Collyr.
Sig. - Two drops in each eye every hour.

703. Rx
Calcii Lact. 15.0
Aq. Menth. Pip
Q. S. 60.0
M ft. Sol.
Sig. - 2 cc. at mealtime.

704. Rx
Acid Nitromuriat. Dil. 30
Spir. Ammonii Arom. 30
M.
Sig. - Two (2) drops in water every two (2) hours.

705. Rx
Hydrargyri Protoiodidi 1.0
Potassii Iodidi 10.0
Tincturae Cardamomi Compositae q.s. 90.0
M.
Sig. - 4 cc q.i.d.

706. Rx
Extracti Nucis Vomicae Pulverati 0.015
Extracti Digitalis 0.015
Sacchari Lactis q.s.
Misce et fiat tales capsulae numero xxiv
Sig. - One capsule three times a day.

707. Rx
Quine ine sulfate 2 cc.
Potassium Acetate 8 cc.
Aromatic Sulfuric Acid 2 cc.
Distilled Water to make 30 cc.
Mix them.
Label - Teaspoonful before meals.

708. Rx

Tincturae Ferri Chloridi		12.
Liquoris Ammonii Acetatis		15.
Ammonii Carbonatis		2.
Syrupi Aurantii		30.
Aquae	qs	240.

Misce ft. mist
Sig. - 4 cc. morning and evening.

709. Rx

Liquoris Potassii Citratis		
Spiriti Aethylis Nitritis		
Syrupi		
Tincturae Aconiti	aa	30.0

M.
Sig. - Teaspoonful three times a day.

710. Rx

Acidi Acetylsalicylici	2.0
Codeinae	0.4
Aminopyrinae	2.0

M. et div. in chart. cerat. vi
Sig. - One powder at night.

711. Rx

Saturated Solution of Potassium Iodide	30

Sig. - gtt. x as directed.

712. Rx

Syr. Ferri Iodidi	10.0
Pot. Iodide	10.0
Aq. Dest.	10.0

Sig. - gtt XV t.i.d.

713. Rx

Strychninae Sulfatis		0.06
Potassii Bromidi		5.00
Alcoholis		30.00
Aquae	qs	120.00

Ft. Sol.
Sig. - 4 cc. a. c.

714. Rx

Sodii Bicarbonatis	3.
Acidi Acetylsalicylici	3.
Amyli	10.

M. ft. chart. xv
Sig. - 1 q 4 h

715. Rx

Ammon. Carb.	15
Pulv. Ipecac	15
Syr. Scillae	30
Syr. Pruni Virg. qs.	120

Ft. Sol.
Sig. - 4 cc. omnia 3 hora.

716. Rx

Sodium Salicylate	5.0
Glycerin	3.0
Methyl Salicylate	0.06
Tincture of Ferric Chloride	3.0
Citric Acid	0.3
Solution of Ammonium Acetate qs	60.0

Mix.
Sig. - 8 cc. 2 or 3 times a day

717. Rx

Tincturae Cardamomi Compositae	30
Spiritus Chloroformi	30
Codeinae	0.3
Pepsini	2
Aquae Destillatae qs	120

Misce

Sig.-Agit. vas. 4 cc q.i.d.

718. Rx

Quin. Sulf.	4.0
Tr. Nuc. Vom.	2.0
Sp. Ammon. Arom.	8.0
Syr. Aurant.	25.0
Mucil. Acac.	15.0
Aq. qs	180.0

Ft. mist.

Sig.-Tablespoonful before meals

719. Rx

Liq. Ammon. Acet.	60
Ammon. Carb.	6
Succ. Limon.	60

Ft. sol.

Sig.-Teaspoonful every hour.

720. Rx

Antipyrine	3 0
Sodium Salicylate	3 0

Mix and prepare 15 powders.

Label-One (1) powder three times a day.

721. Rx

Chloralis Hydratis	20.gm.
Sodii Bromidi	10.gm.
Barbitali	2.gm.
Tincturae Belladonnae	20.gm.
Elixiris Aromatici qs	120.cc.

Misce.

Sig.-8 cc. hora decubitus.

722. Rx

Soluble Phenobarbital	0.75
Tincture of Belladonna	10.00
Compound Elixir of Pepsin up to	120.00

Sig.-Teaspoonful every four hours.

723. Rx

Spiriti Glycerylis Trinitratis	2.
Aquae Destillatae qs	120.

Misce fiat solutio

Sig.-Cochleare parvum pro ro nata.

724. Rx

Liq. Acid. Arsen.	15.00
Alcoholis	15.00
Strych. Sulf.	0.06

Ft. Sol.

Sig.-gtt.iv t.d.

725. Rx
Sod. Salicyl. 2.
Acid. Sulfuric. Arom. 6.
Aq. Menth. Pip. qs 60.
M. ft. mist.
Sig.-4 cc. alt. hor.

726. Rx
Ac. Nit. Hyd. 8.0
Tr. Card. Co. qs 30.0
M.
Sig.-gtt. v a.c.

727. Rx
Mag. Sulf. 30.
Elix. Arom. 120.
M. Ft. Sol.
Sig.-15 cc at night.

728. Rx
Bism. Subnit. 6.0
Sodii Iodidi 6.0
Misce et in chart. No. xxiidiv.
Sig.-Capiat unam ante cibo.

729. Rx
Benzylis Benzoatis 5.0
Acaciae 5.0
Aquae qs 6.0
Misce sec art.
Sig.-Cochleare parvum quaque quatuor horae.

730. Rx
Phenylis Salicylatis 0.3
Phenolis
Chlorobutanolis aa 0.05
Misce et dent. tales doses decim.
Sig.-Capiat capsulam unam quaque duo horae.

731. Rx
Potass. Cit.
Potass. Acet. aa 15
Liq. Ferri et Ammon.
Acet atis qs 120
Ft. sol.
Sig.-Dessertspoonful twice a day.

732. Rx
Antipyrinae 10
Spiriti Aethylis
Nitritis 20
Liquoris Potassii
Citratis qs 120
Ft. Sol.
Sig.-4 cc. q hor. feb. dur.

733. Rx
Potassii Acetatis 15.gm.
Tr. Belladonnae 10.cc.
Elix. Arom. qs 60.cc.
Misce et fiat solutio.
Sig.-Teaspoonful three times a day before meals.

734. Rx

Potassii Bromidi	8 gm.
Chloralis Hydratis	2 gm.
Aquae Chloroformi	30 cc.

Misce

Sig.-2 cc. in hot aq. h.s.

Label: One teaspoonful in hot water at bedtime.

735. Rx

Sod. Salicyl.	4.5
Aq. Menth. Pip. qs	60.0

M.

Sig.-Teaspoonful q.i.d.

736. Rx

Olei Ricini	15.0
Phenyl. Salicyl.	1.0
Acaciae	2.0
Aq. Cinnam. qs	60.0

Ft. Emulsio.

Sig.-Take half a bottle at once. Repeat tomorrow.

737. Rx

	Gm. or cc.
Petrolat. Liq.	120
Fldext. Casc. Sag. Arom.	30
Acaciae qs	
Aq. Dest. qs	240

M.S.A.

Sig.-Tablespoonful before breakfast.

738. Rx

	Gm. or cc.
Creosote	2
Ol. Olive qs	

Div. in caps. no. x

Sig.-One three times a day.

739. Rx

	Gm. or cc.
Caffeinae Citratis	1
Strych. Sulfatis	001
Sacch. Lact. qs	

M. Ft. tal. caps. v

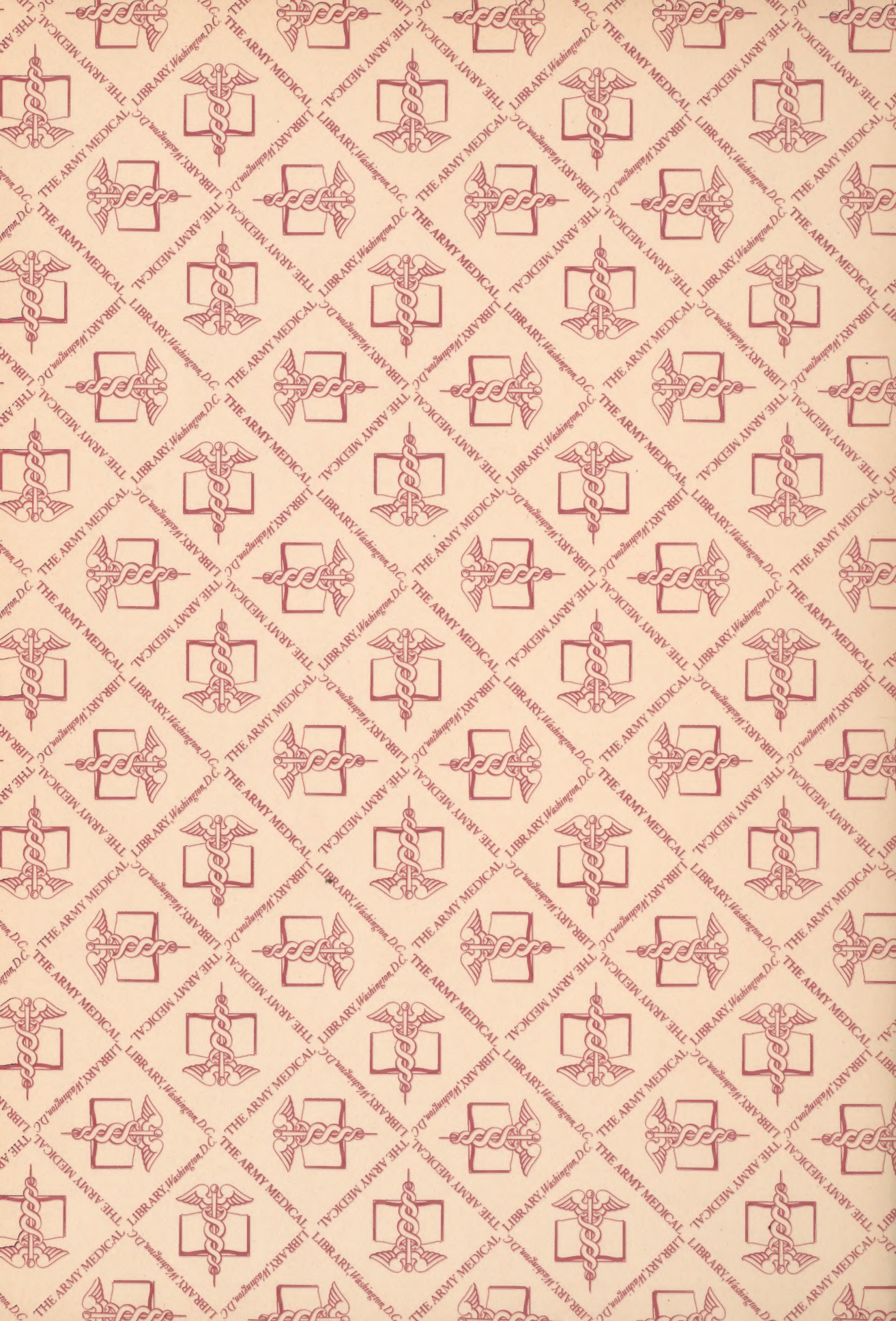
Sig.-One after breakfast and lunch.

740. Rx

Strych. Sulf.	0.016gm
Alcoholis	20. cc
Dist. Water	35. cc
Liq. Pot. Iodid.	5. cc

Solve.

Sig. - 4 cc. p.c.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